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INSTALLATION RESTORATION PROGRAM

FEASIBILITY STUDY FOR SITES 1, 3, 5, 6, 7, 8, AND 9

FINAL

MICHIGAN AIR NATIONAL GUARD
ALPENA COMBAT READINESS TRAINING CENTER

APRIL 1996

Prepared For:

Air National Guard
Andrews AFB, Maryland

Prepared By:

Montgomery Watson
Novi, Michigan

MONTGOMERY WATSON

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APPENDICES

ACRONYM LIST

AGE	Aerospace Ground Equipment
ANG/CEVR	Air National Guard Readiness Center/Civil Engineering Installation Restoration
AOPs	advanced oxidation processes
ARARs	Applicable or Relevant and Appropriate Requirements
ASTs	aboveground storage tanks
AVGAS	aviation gasoline
bgs	below ground surface
BRA	Baseline Risk Assessment
BTEX	benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation Liability Act
COPCs	chemicals of potential concern
CRTC	Combat Readiness Training Center
cy	cubic yards
DOD	U.S. Department of Defense
F	Fahrenheit
FS	Feasibility Study
ft	feet
GAC	granulated activated carbon
gal	gallons
gpd	gallons per day
gpm	gallons per minute
GRAs	general response actions
GSI	groundwater/surface water interface
HQ	Hazard Quotient
IRP	Installation Restoration Program
MCLs	Federal Maximum Containment Levels
MDEQ	Michigan Department of Environmental Quality
MERA	Michigan Environmental Response Act
mi	miles
MIANG	Michigan Air National Guard
msl	mean sea level

ACRONYM LIST

NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
Op Memo	Operational Memorandum
PA	Public Act
PAHs	poly-nuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
POL	Petroleum, Oils, and Lubricants
POTW	publicly owned treatment works
ppb	parts per billion
RAOs	remedial action objectives
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
SARA	Superfund Amendments and Reauthorization Act
SI	site investigation
SOV	soil organic vapor
SVOCs	Semi-Volatile Organic Compounds
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
VOCs	volatile organic compounds
WTF	Wastewater Treatment Facility

EXECUTIVE SUMMARY

This report documents the feasibility study (FS) activities performed for the Air National Guard Readiness Center (ANG) at the Alpena Combat Readiness Training Center (CRTC), Alpena County Regional Airport, Alpena, Michigan under the U.S. Department of Defense Installation Restoration Program (IRP). As part of the IRP, this FS is intended to screen and evaluate remedial action alternatives for Alpena CRTC identified during previous investigations at the base. The FS activities were conducted in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA).

This FS Report is based on the information presented in the Final Remedial Investigation (RI) Report prepared by The Earth Technology Corporation (June 1995). The RI Report detailed the types and concentrations of contamination detected at each of the Alpena sites.

The recommended alternative for each of the Alpena CRTC sites evaluated in this FS are summarized below:

- **Site 1 - POL Storage Area - Limited Action Alternative**

  The recommended alternative for Site 1 involves the monitoring of the soil and groundwater contamination for 10 years as the constituent levels naturally attenuate. The alternative includes institutional controls to protect human health while the site is being monitored. The institutional controls will include restrictions on the use of groundwater and requirements for construction activities (such as the use of respirators).

- **Site 3 - Former Site of County Garage - No Action Alternative**

  Based on the analysis completed during the FS process, no additional remedial actions are required for Site 3.

- **Site 5 - Second Fire Training Area - Limited Action Alternative**

  The recommended alternative for Site 5 involves the monitoring of groundwater contamination for 10 years as the constituent levels naturally attenuate. The alternative also includes institutional controls to protect human health while the site is being monitored. The institutional controls will include restrictions on the use of groundwater.

- **Sites 6 and 7 - Former Solid Waste Landfill and First Fire Training Area - Limited Action Alternative**

  The recommended alternative for Sites 6 and 7 involves the monitoring of groundwater contamination for 5 years as the constituent levels naturally attenuate. The alternative also includes institutional controls to protect human health while the site is being monitored.

- **Site 8 - Former Site of Hanger 9 - No Action Alternative**

  Based on the analysis completed during the FS process, no additional remedial actions are required for Site 8.

- **Site 9 - Radar Tower Site - Limited Action Alternative**

  The recommended remedial alternative for Site 9 involves the monitoring of groundwater contamination for 10 years as the constituent levels naturally attenuate. The alternative also includes institutional controls to protect human health while the site is being monitored. The institutional controls will include restrictions on the use of groundwater.

1.0 INTRODUCTION

This report documents the feasibility study (FS) activities performed for the Air National Guard Readiness Center/Civil Engineering Environmental Installation Restoration (ANG/CEVR) at the Michigan Air National Guard's (MIANG) Alpena Combat Readiness Training Center (CRTC), Alpena County Regional Airport, Alpena, Michigan, under the U.S. Department of Defense's (DOD) Installation Restoration Program (IRP). As part of the IRP, this FS is intended to screen and evaluate possible remediation alternatives for the Alpena CRTC sites. The IRP at the Alpena CRTC is being conducted in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). Montgomery Watson has been contracted to prepare this FS report under contract DAHA90-94-D-0013, Delivery Order 12.

1.1 PURPOSE AND ORGANIZATION OF REPORT

The purpose of this FS is to develop, screen, and evaluate remedial alternatives which are potentially capable of meeting the remedial action objectives (RAOs) identified for the sites at the Alpena CRTC. The first step in the FS process is to identify the RAOs and general response actions (GRAs). RAOs consist of medium-specific or site-specific goals for protecting human health and the environment. GRAs are actions that satisfy the remedial action goals.

After the identification of the RAOs and the GRAs, the next step in the FS process is to identify and screen technologies. In this step, the universe of potentially applicable technology types and process options are reduced by evaluating the options with respect to technical implementability. The retained technologies are then combined to form remedial alternatives capable of meeting the RAOs applicable to a particular site. These remedial alternatives are screened based on effectiveness, implementability, and cost. The purpose of this screening is to reduce the number of alternatives that must undergo a more thorough and extensive evaluation during the detailed analysis step.

The final step in the FS process is the detailed analysis of the remedial alternatives retained in the preliminary screening. The remedial alternatives are evaluated against nine criteria developed by the U.S. Environmental Protection Agency (USEPA) to address the CERCLA requirements (USEPA, 1988).

By direction of the ANG/CEVR, the process used in the preparation of this FS report has been streamlined in an effort to reduce the number of technologies and alternatives screened during the preliminary steps of the FS process. The evaluation of the regulatory framework, the development of the RAOs and GRAs, the identification and screening of technologies, and the development of remedial alternatives are based on media specific categories. The media specific categories result in fewer repetitive alternatives during the initial screening process. The final detailed evaluation and recommendation of remedial alternatives is completed on a site by site basis. This streamlined approach is effective for the Alpena CRTC because the sites have similar types of impacts. The initial screening of media specific categories provides sufficient information to retain the most applicable alternatives for the detailed analysis completed on a site by site basis.

This FS report is divided into the sections outlined below:

- Section 1.0 - Introduction. This section contains the purpose and organization of the report, background information on the Alpena CRTC, including a description and history of the base, a brief summary of the nature and extent of the contaminants, a qualitative discussion of potential contaminant fate and transport, and a summary of the Baseline Risk Assessment (BRA). In addition, Section 1 presents information on the streamlined process used in the development of this FS report.

- Section 2.0 - Remedial Action Objectives and General Response Actions. This section presents the media specific categories developed for the Alpena CRTC sites that are used in the analysis in Sections 3.0 and 4.0. In addition, this section discusses the Applicable or Relevant and Appropriate Requirements (ARARs), establishes the RAOs and the GRAs for the sites, and presents the identification and screening of remedial technologies.

- Section 3.0 - Development and Screening of Remedial Alternatives. This section presents the initial screening of the media specific alternatives based on the technologies retained in Section 2.0.

- Section 4.0 - Detailed Analysis of Remedial Alternatives. This section includes the development and evaluation of alternatives for each of the Alpena CRTC sites using the evaluation criteria recommended by the USEPA. In this section, the media specific alternatives retained in Section 3.0 are combined into site specific alternatives for each of the Alpena CRTC sites.

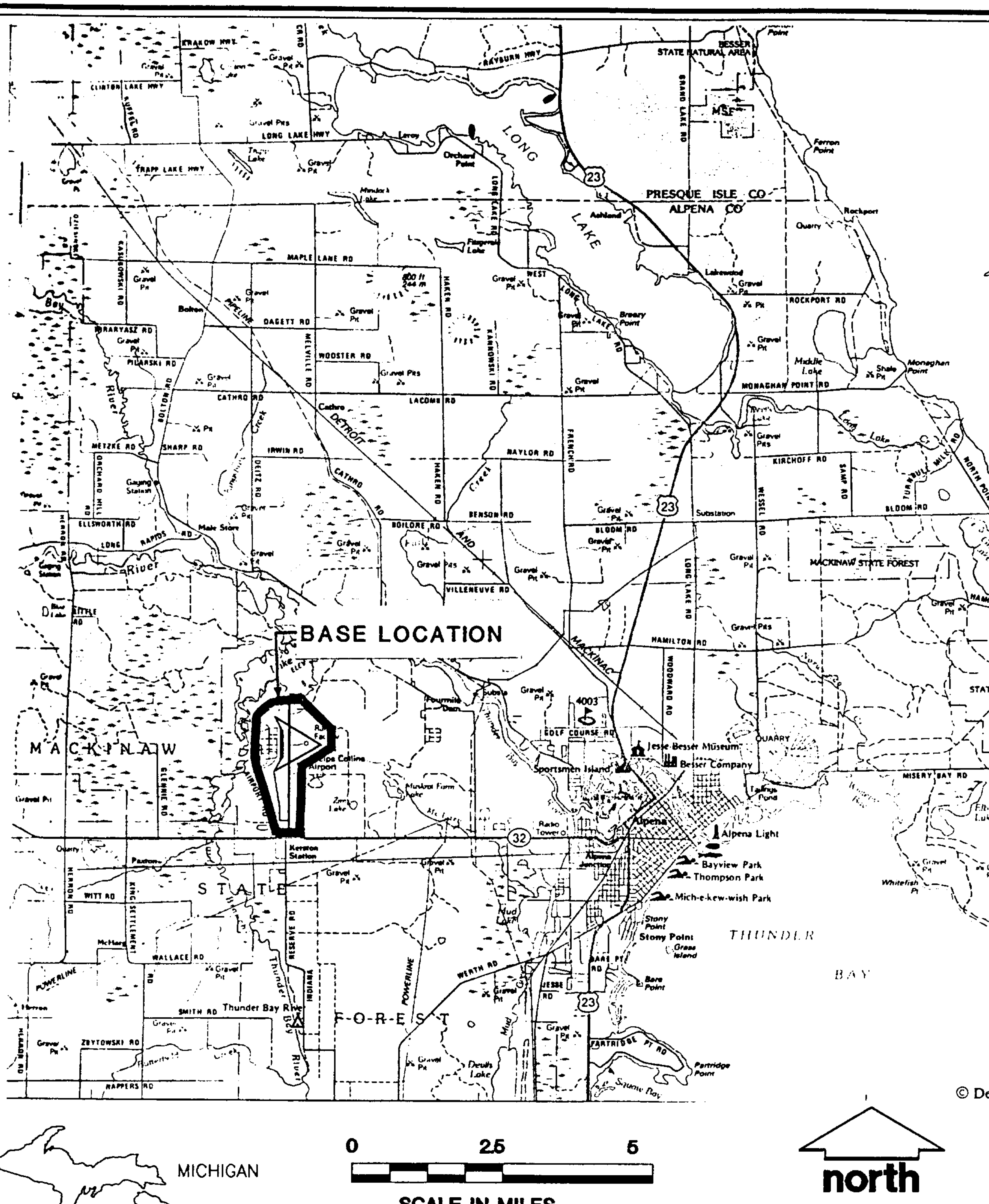
- Section 5.0 - Recommended Alternatives. This section presents the recommended remedial alternative.

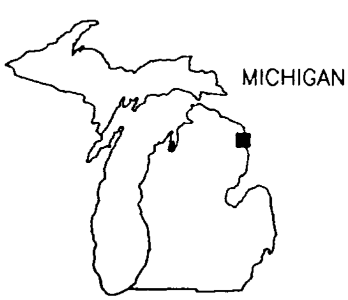
1.2 BACKGROUND INFORMATION

This section summarizes background information for the Alpena CRTC, including the location, description of past operations, geology, hydrogeology, nature and extent of contamination, contaminant fate and transport, and the BRA. This information was condensed from the Final Remedial Investigation Report (RI Report) (The Earth Technology Corporation, 1995).

1.2.1 Base Description

The Alpena CRTC is located within the Central Lowland Physiographic Division of Michigan (Miller and Twenter, 1986), approximately 5 miles (mi) west of the city of Alpena at the Alpena County Regional Airport. The regional location of the facility is shown in Figure 1-1. The Alpena County Airport occupies approximately 3,000 acres of land. The MIANG leases and has exclusive rights to approximately 600 acres of that property for the Alpena CRTC. Figure 1-2 shows the entire Alpena County Regional Airport and identifies the land leased by the MIANG. As shown in Figure 1-2, the main portion of the land leased by the MIANG is bordered by Lake Winyah on the west and north, by the airport runways to the east, and by Security Street to the south. In addition, the MIANG leases a section of land to the east of the runways which is centered around Munitions Road.





QUADRANGLE LOCATION

NOTE

BASE MAP DEVELOPED FROM THE MICHIGAN ATLAS AND GAZETTEER PAGE 84, FOURTH EDITION SECOND PRINTING.

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GENERAL MAP LOCATION

FIGURE 1-1

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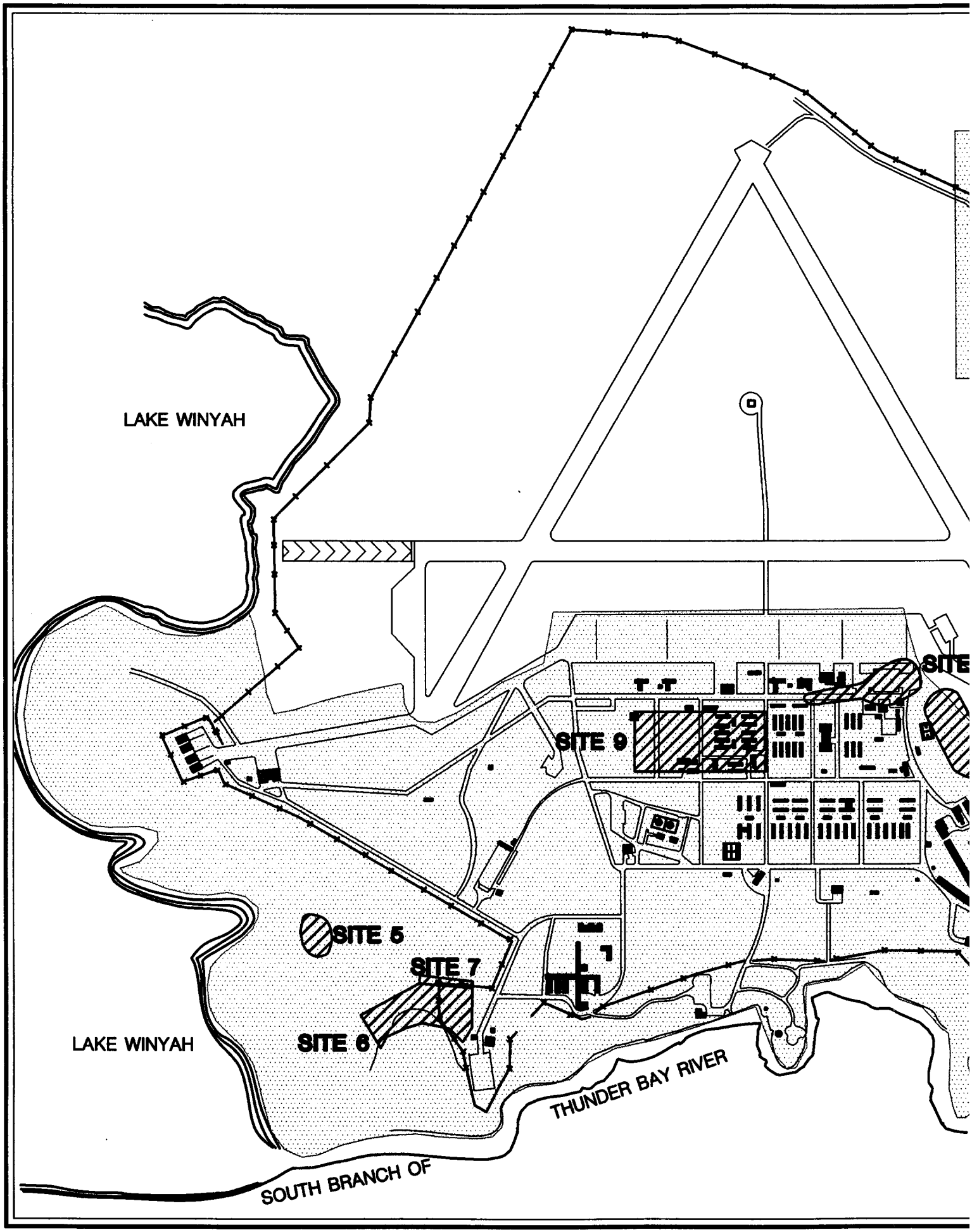
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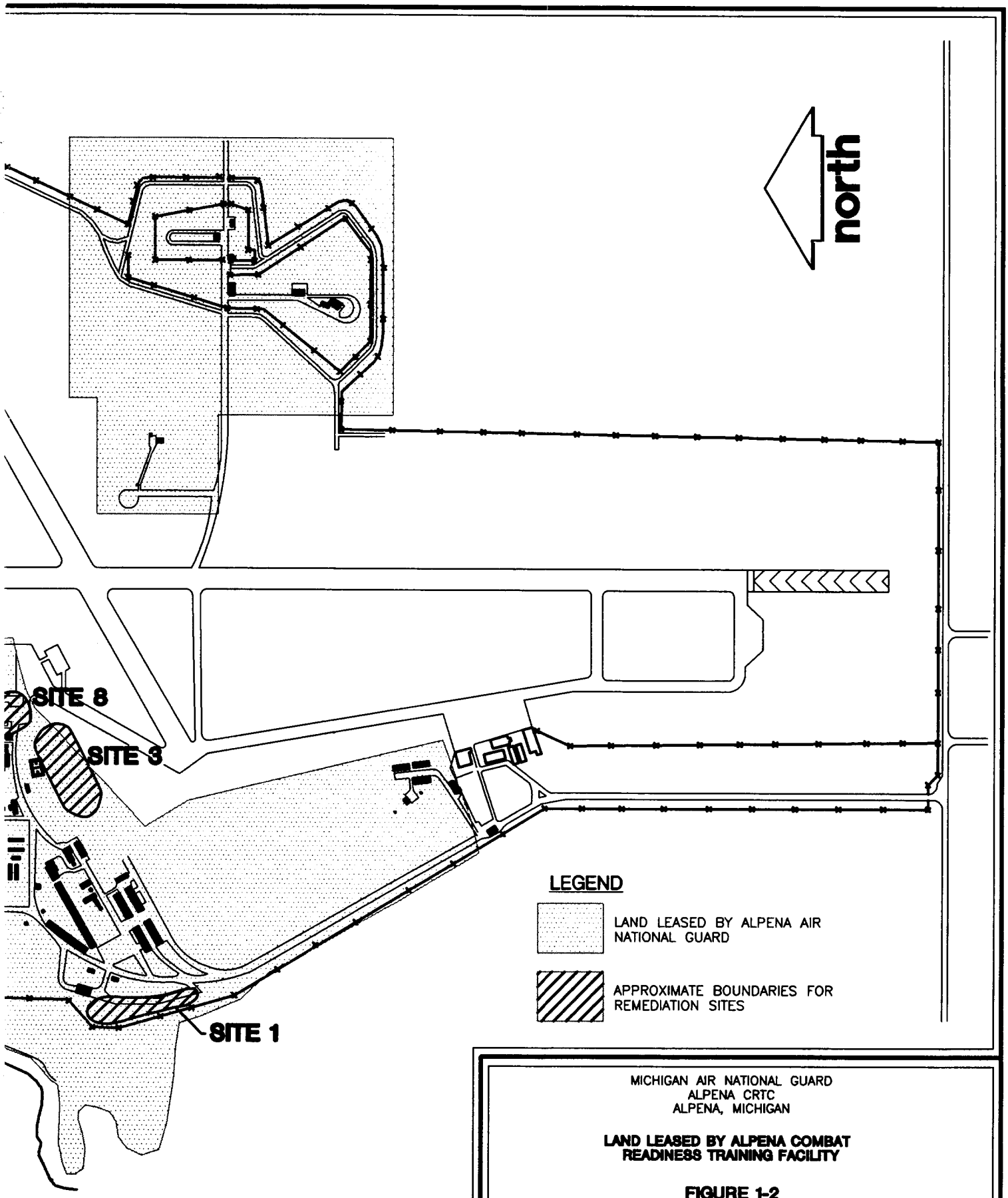
LAKE WINYAH
THUNDER BAY RIVER
SOUTH BRANCH OF



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LAND LEASED BY ALPENA COMBAT READINESS TRAINING FACILITY

FIGURE 1-2

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The climate of the Alpena CRTC is characterized as semi-maritime and is affected by the proximity of Lake Huron to the east. The topography of the facility is a result of glacial activity, sinkhole development, and anthropomorphic influences. The general land surface elevations on the facility vary between 672 feet (ft) above mean sea level (msl) to 688 ft above msl. The physical characteristics of the facility are discussed in detail in Section 1.7 of the RI Report.

1.2.2 Base History

The Alpena CRTC has a long history of military and training use. Since 1952, the Alpena CRTC has primarily been used as a training facility. Training takes place year-round with the greatest influx of personnel occurring during the months of April through September. The Alpena CRTC has had no assigned aircraft since the mid-1950s, except for a period between 1964 and 1972, when a detachment of aircraft and personnel were on 24-hour intercept alert.

The following is a brief discussion of each of the Alpena sites included in this FS. The site locations are shown on the base map (Figure 1-2).

1.2.2.1 Site 1 - Petroleum, Oil, and Lubricants Storage Area. Site 1 was once a fuel storage area which consisted of various aboveground storage tanks (ASTs), associated distribution lines, and dispensers. The Site 1 Petroleum, Oils, and Lubricants (POL) area was used for fuel storage from 1952 until 1987. At that time, the site was dismantled and the new POL area, west of Site 9, was put into use. Figure 1-3 shows the layout of Site 1.

Fuels stored and dispensed at the Site 1 POL facility included JP-4 jet fuel and aviation gasoline (AVGAS). JP-4 was stored in ASTs with a total capacity of 447,000 gallons (gal) (Hazardous Materials Training Center, 1985). The Site 1 POL area also maintained three ASTs with an approximate capacity of 10,000 gal used to store the AVGAS.

In May 1983, one of the former ASTs located southwest of Building 15 released approximately 500 to 800 gal of JP-4. It was reported by facility personnel that within minutes nearly 90 percent of the spilled fuel was recovered and the remainder evaporated or absorbed into the ground. The

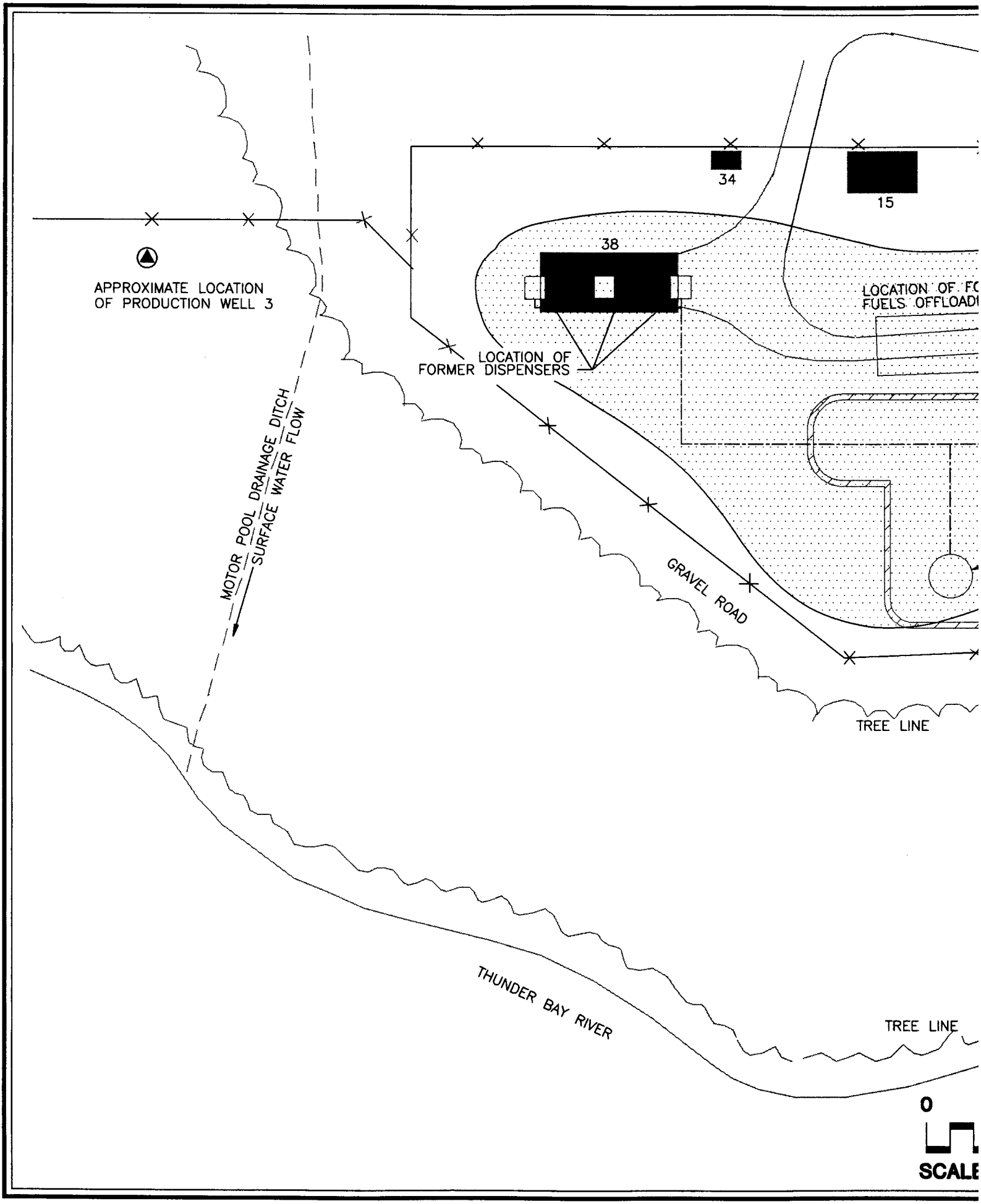
preliminary visual site inspection in August 1984 found no environmental stress due to the impacts of the spill (Hazardous Materials Training Center, 1985).

Currently, Site 1 lies within a fenced area inside the Alpena CRTC. Most of Site 1 is now a gravel covered parking lot, used for parking large vehicles. Most equipment and structures associated with the Site 1 POL area were dismantled in 1987. Buildings 15 and 34 were not dismantled. In addition, a pole barn (Building 38) was constructed in 1991 to store equipment for the roads and grounds personnel.

1.2.2.2 Site 3 - Former Site of County Garage. Alpena County operated a maintenance garage at Site 3 from the late 1940s until approximately 1973. An unspecified amount of waste oil was reportedly used as a means of dust control around the garage parking lots and roads (Hazardous Materials Training Center, 1985). Currently, the site is mostly a grassy area, with the exception of some gravel roads. There is a wooded area in the southern portion of the site. Figure 1-4 shows the location of Site 3.

1.2.2.3 Site 5 - Second Fire Training Area. This site was used by MIANG units for training exercises. From 1965 to 1974, approximately two to three fire training exercises were conducted each year. Approximately 300 gal of JP-4 were applied to the ground and ignited in each training exercise. The site lacked formal containment structures such as a concrete pad or berm. The site has not been used for fire training since 1974. Site 5 is shown in Figure 1-5.

1.2.2.4 Sites 6 and 7 - Former Solid Waste Landfill and First Fire Training Area. Sites 6 and 7 have been combined and are considered as one site due to their proximity. Site 6 was reportedly used for disposal of waste paints, spent solvents, oils, and waste fuel, in addition to general refuse. The RI Report indicates that historical photographs show burial of crushed drums. Site 7 was used for fire training exercises from 1952 until 1965. An average of ten fire training exercises were conducted each year between 1952 and 1954. After 1954, the frequency of exercises decreased to approximately two per year. During each training exercise 150 to 500 gal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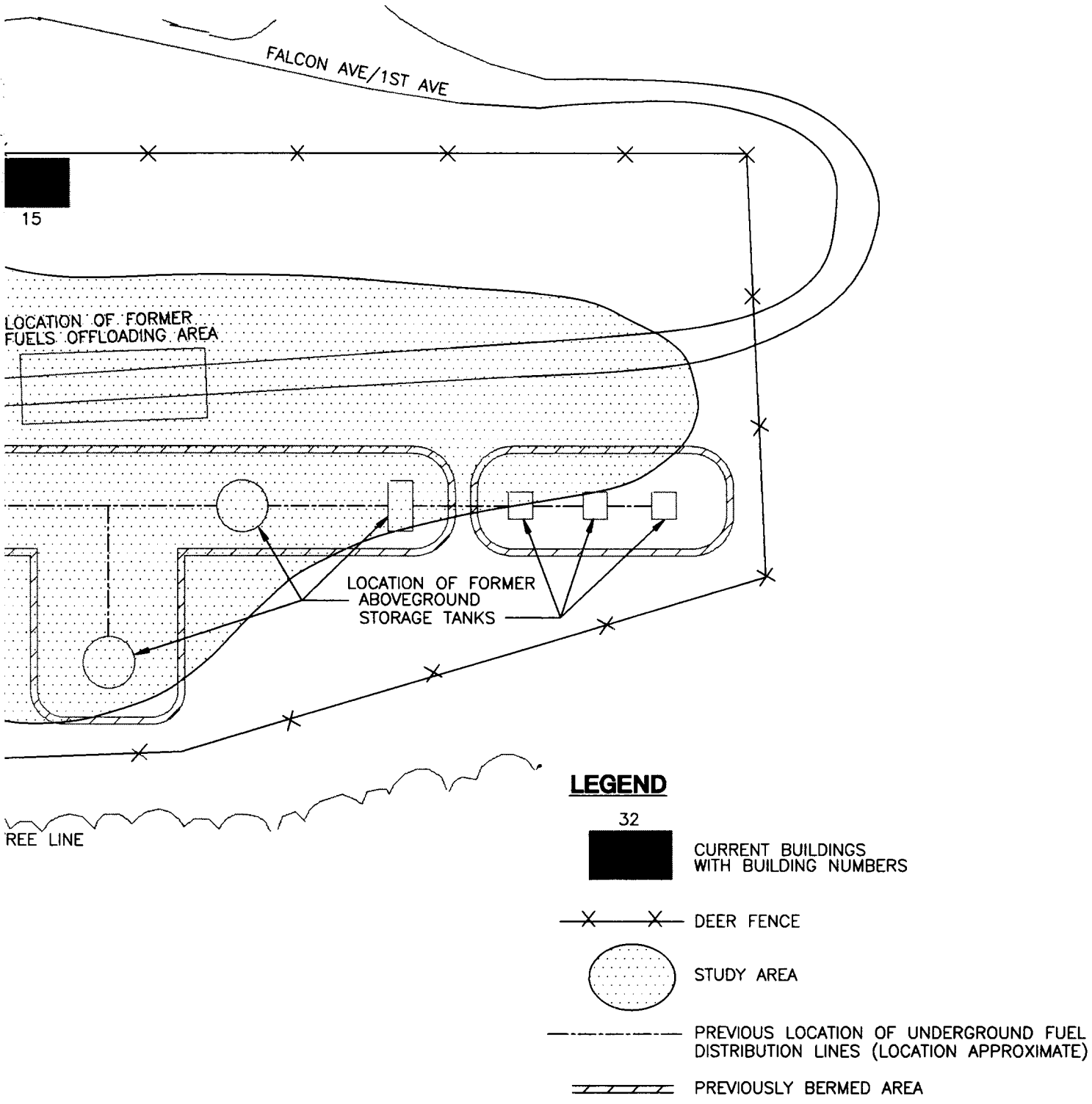

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SITE 1 POL STORAGE AREA
SITE FEATURES MAP

FIGURE 1-3

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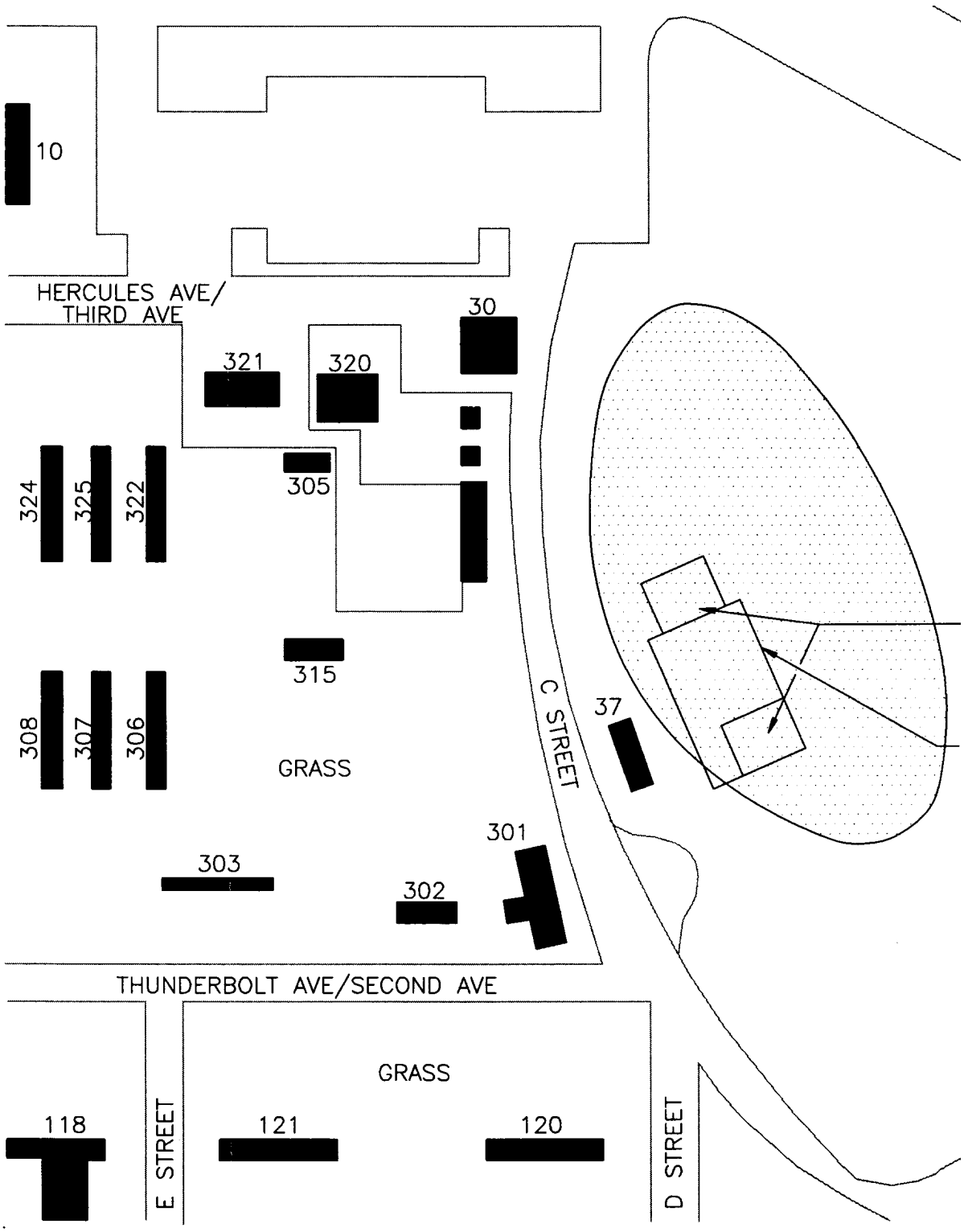
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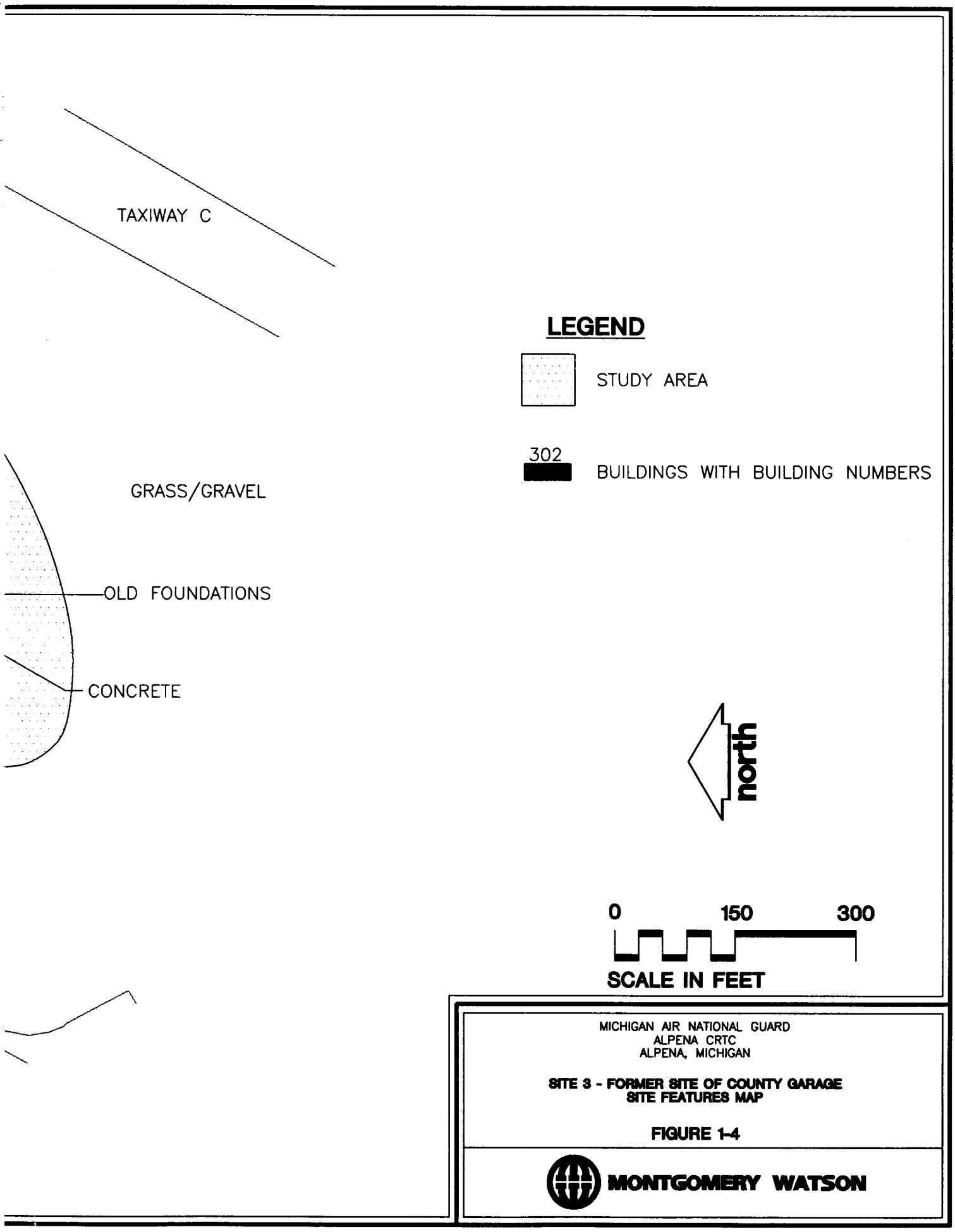

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SITE 3 - FORMER SITE OF COUNTY GARAGE
SITE FEATURES MAP

FIGURE 1-4

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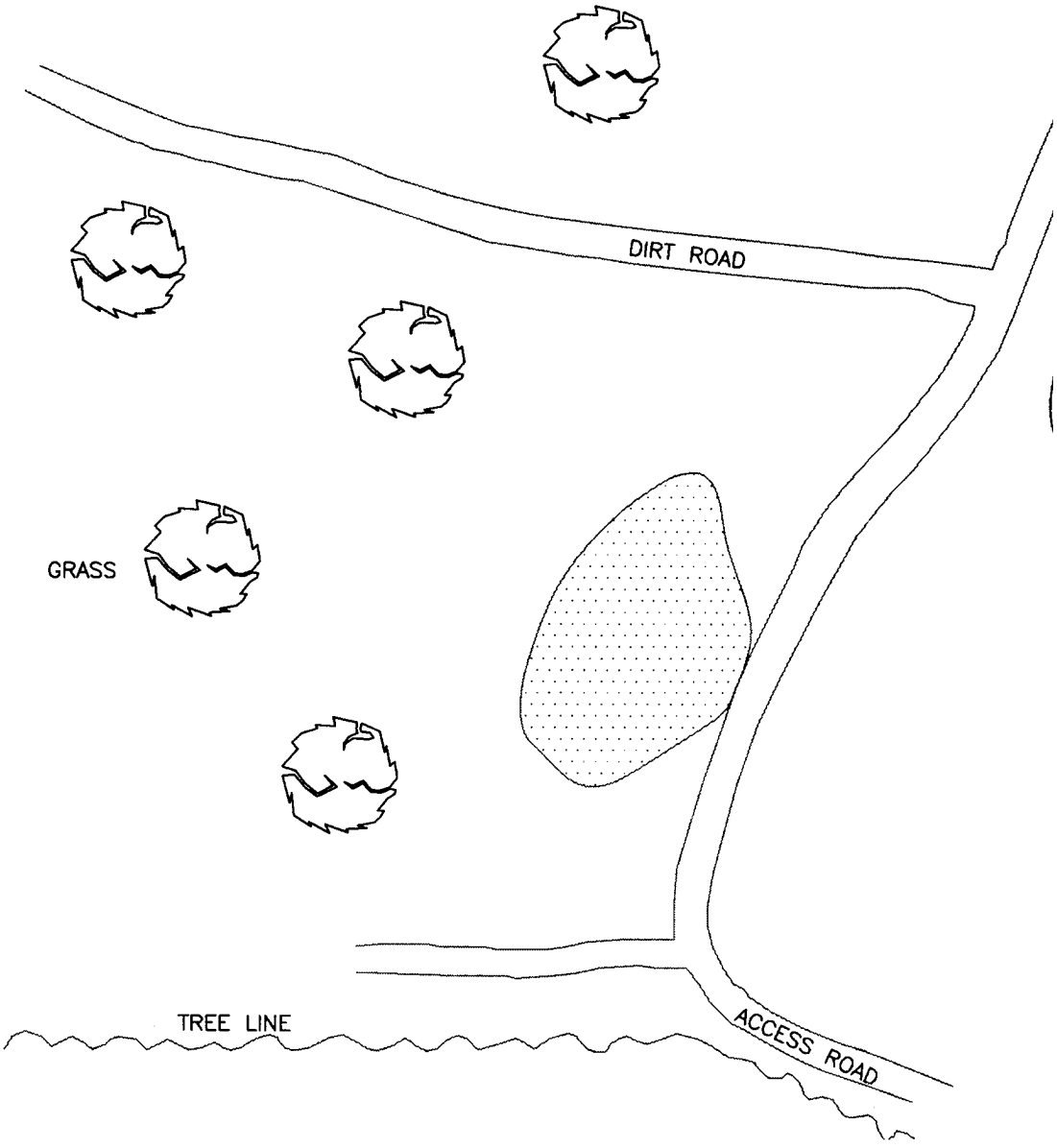
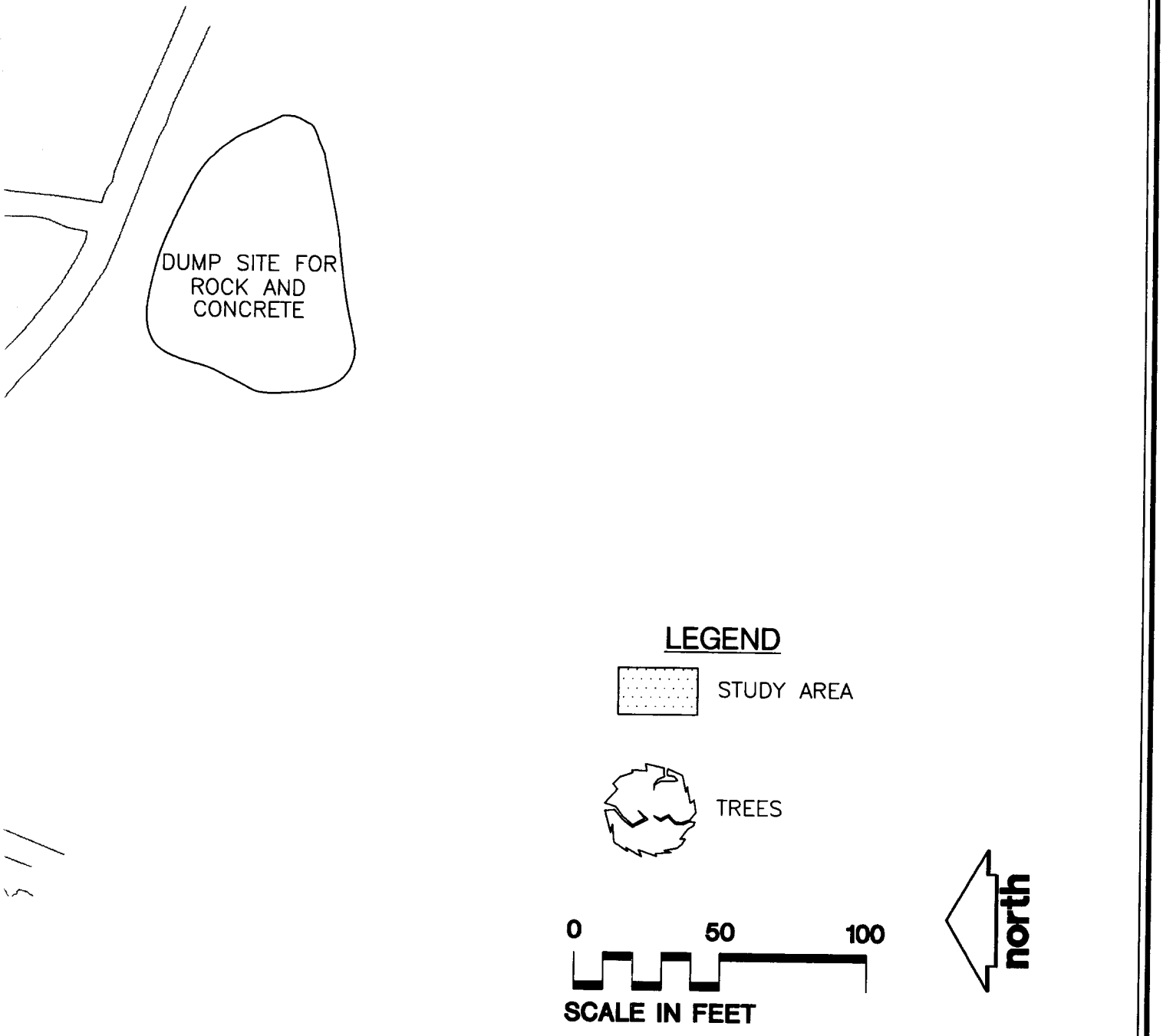

DIRT ROAD
GRASS
TREE LINE
ACCESS ROAD



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**SITE 5 - SECOND FIRE TRAINING AREA:
SITE FEATURES MAP**

FIGURE 1-5

MONTGOMERY WATSON

of waste fuels, waste oils, and spent solvents were burned. The fire area lacked any formal containment structures, such as a concrete pad or berm. Figure 1-6 shows the locations of Site 6 and Site 7.

1.2.2.5 Site 8 - Former Site of Hangar 9. Site 8 is the former location of Hangar 9, which was built in 1942 and dismantled in 1978. The entire concrete floor of the former hangar has been incorporated into the parking area east of the control tower. The location of the former hangar building is shown in Figure 1-7.

1.2.2.6 Site 9 - Radar Tower Site. This site consists of the Aerospace Ground Equipment (AGE) Maintenance shop (Building 417) and surrounding areas. The shop maintains ground equipment in support of aircraft operations. Currently, full-time personnel work in the AGE shop. The area around the shop is covered with grass and scattered trees. A wooded area lies to the north of the site. Figure 1-8 shows the area included in this site.

1.2.3 Previous Investigations

This section briefly describes the site investigation (SI) and RI field activities completed at each of the sites. The RI Report contains more detailed discussion of sampling activities.

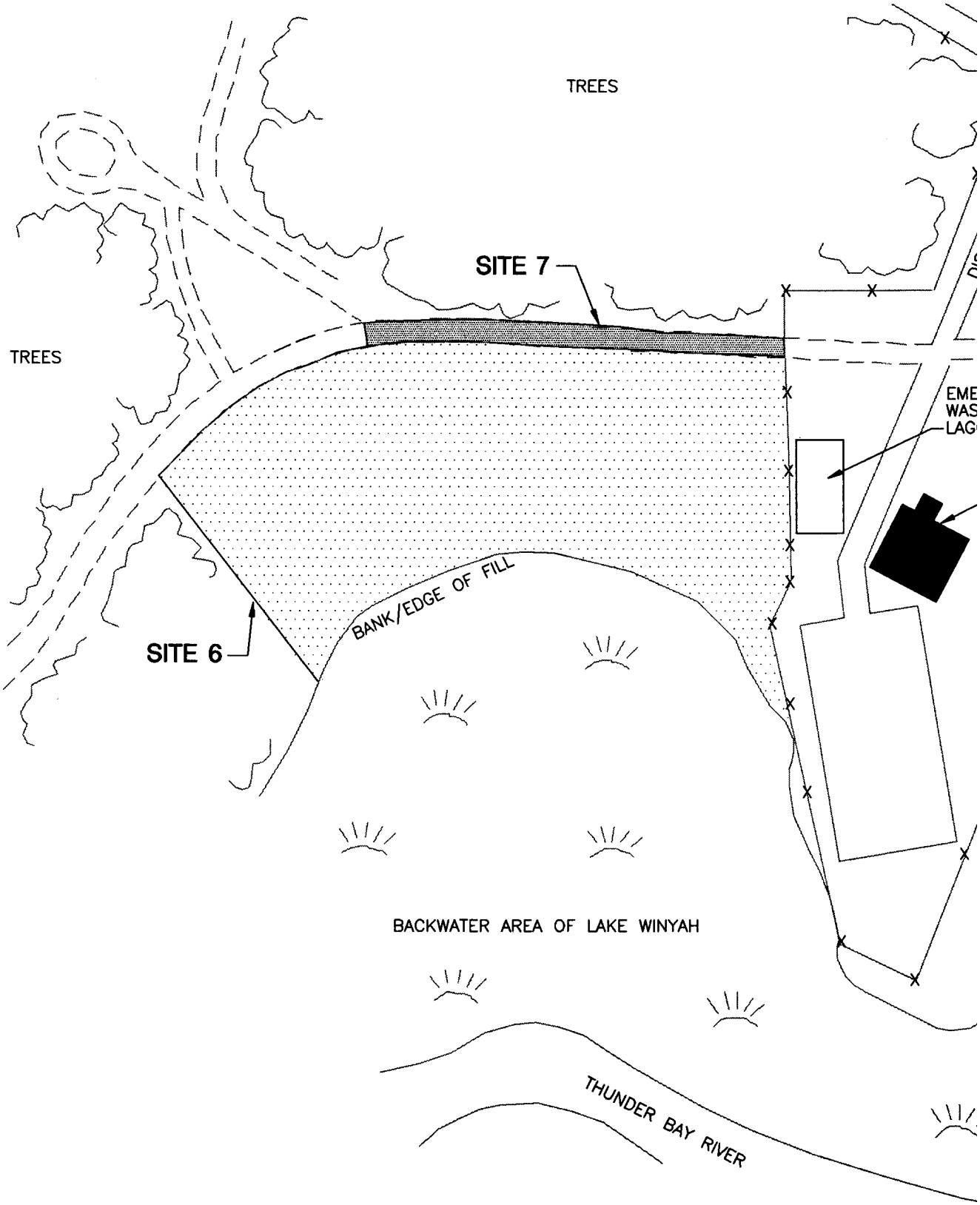
1.2.3.1 Site 1 - Petroleum, Oil, and Lubricants Storage Area. Field investigations to support the IRP for Site 1 began in 1985 with the completion of a soil gas survey. No additional environmental investigations were performed at the site until a SI was initiated in 1992. SI field activities included collection of soil gas and groundwater screening data and the drilling and sampling of three soil borings as described in the Abbreviated SI Report (The Earth Technologies Corporation, 1993). The RI field activities completed at Site 1 included collection and analysis of soil samples, monitoring well installation, sampling and analysis of groundwater, and aquifer slug testing.

1.2.3.2 Site 3 - Former Site of County Garage. The SI at Site 3 consisted of drilling soil borings, installing groundwater monitoring wells, and collecting soil and groundwater samples for analysis. Surface and subsurface SI soil samples were collected in 1990. Three rounds of groundwater sampling were completed as part of the SI, in 1987, 1988, and 1991. As part of the RI, surface geophysical surveys were conducted in 1992. Soil borings, monitoring well installation, and soil and groundwater sampling and analysis were completed in 1993 as part of the RI field activities.

1.2.3.3 Site 5 - Second Fire Training Area. Soil vapor monitoring, soil boring and sampling, and monitoring well installation and groundwater sampling were completed during the SI. Three rounds of groundwater samples were collected as part of the SI, in 1987, 1988, and 1991. The RI included surface geophysical surveys in 1992. In addition, the RI included additional sampling of soil and groundwater in 1993.

1.2.3.4 Sites 6 and 7 - Former Solid Waste Landfill and First Fire Training Area. The SI for Sites 6 and 7 included soil vapor monitoring surveys, magnetic surveys, installation of monitoring wells, and soil, sediment, and groundwater sampling. In addition, the RI included surface geophysical surveys and test pit excavations in 1992. The RI also included installation of additional monitoring wells and soil and groundwater sampling activities.

1.2.3.5 Site 8 - Former Site of Hangar 9. Soil samples were collected and analyzed during installation of soil borings, and monitoring wells were installed and sampled during the SI for Site 8. As part of the RI sampling activities, soil gas and groundwater screening data were collected in 1993. Soil borings, monitoring well installation, and soil and groundwater sampling and analysis comprised the remainder of the RI activities.


TREES
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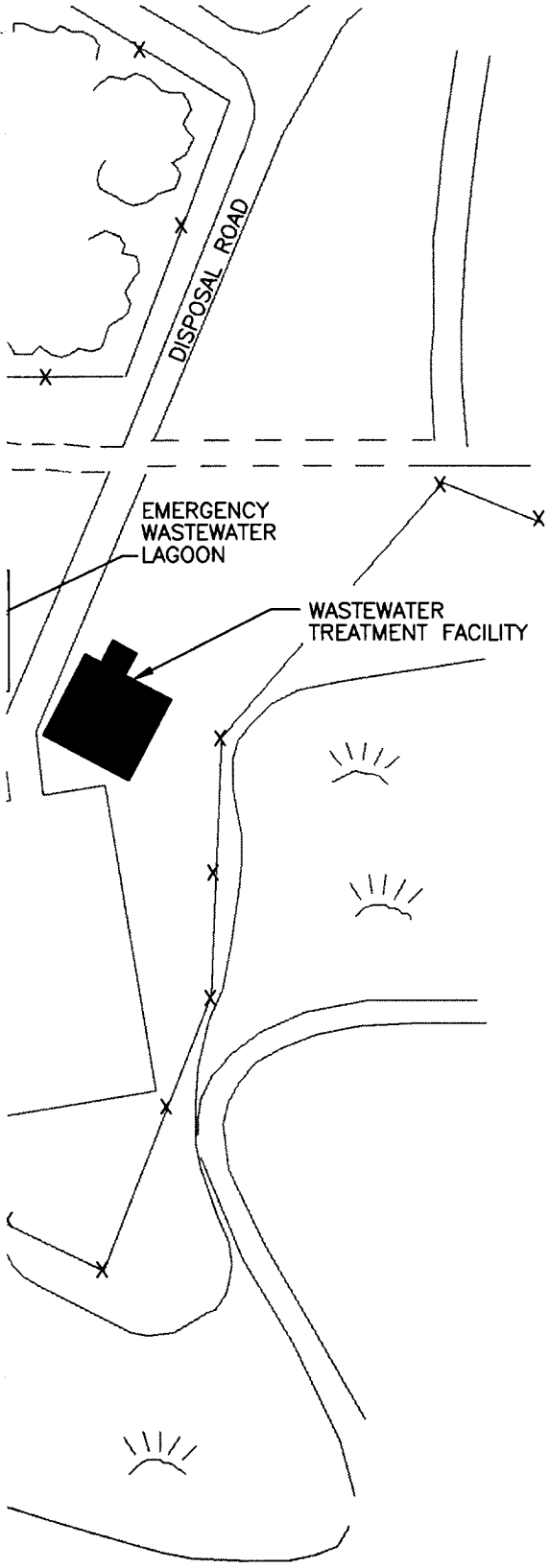


LEGEND

- BUILDING
- DEER FENCE
- MARSH AREAS
- TREES
- SITE 6 STUDY AREEA
- SITE 7 STUDY AREA

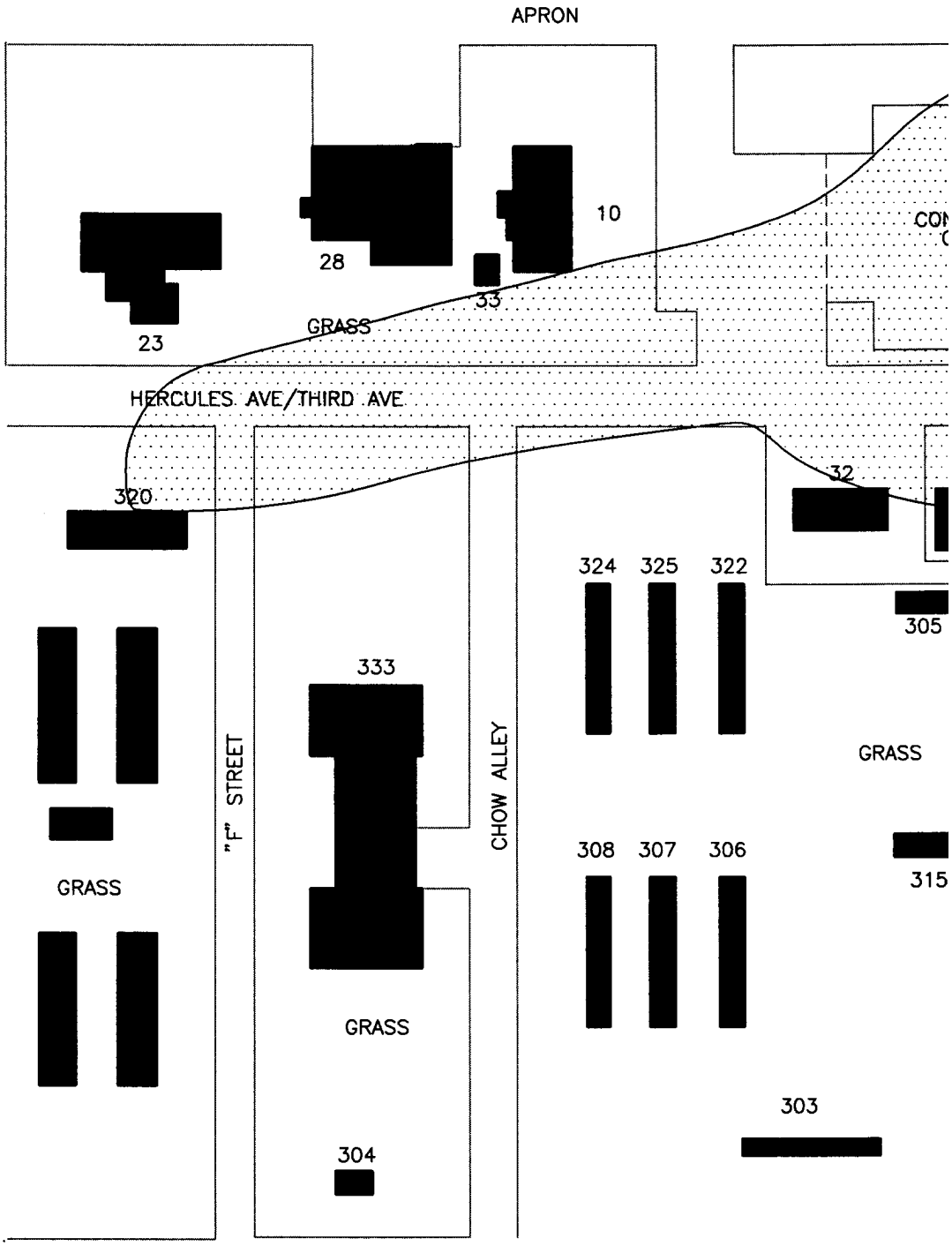
north

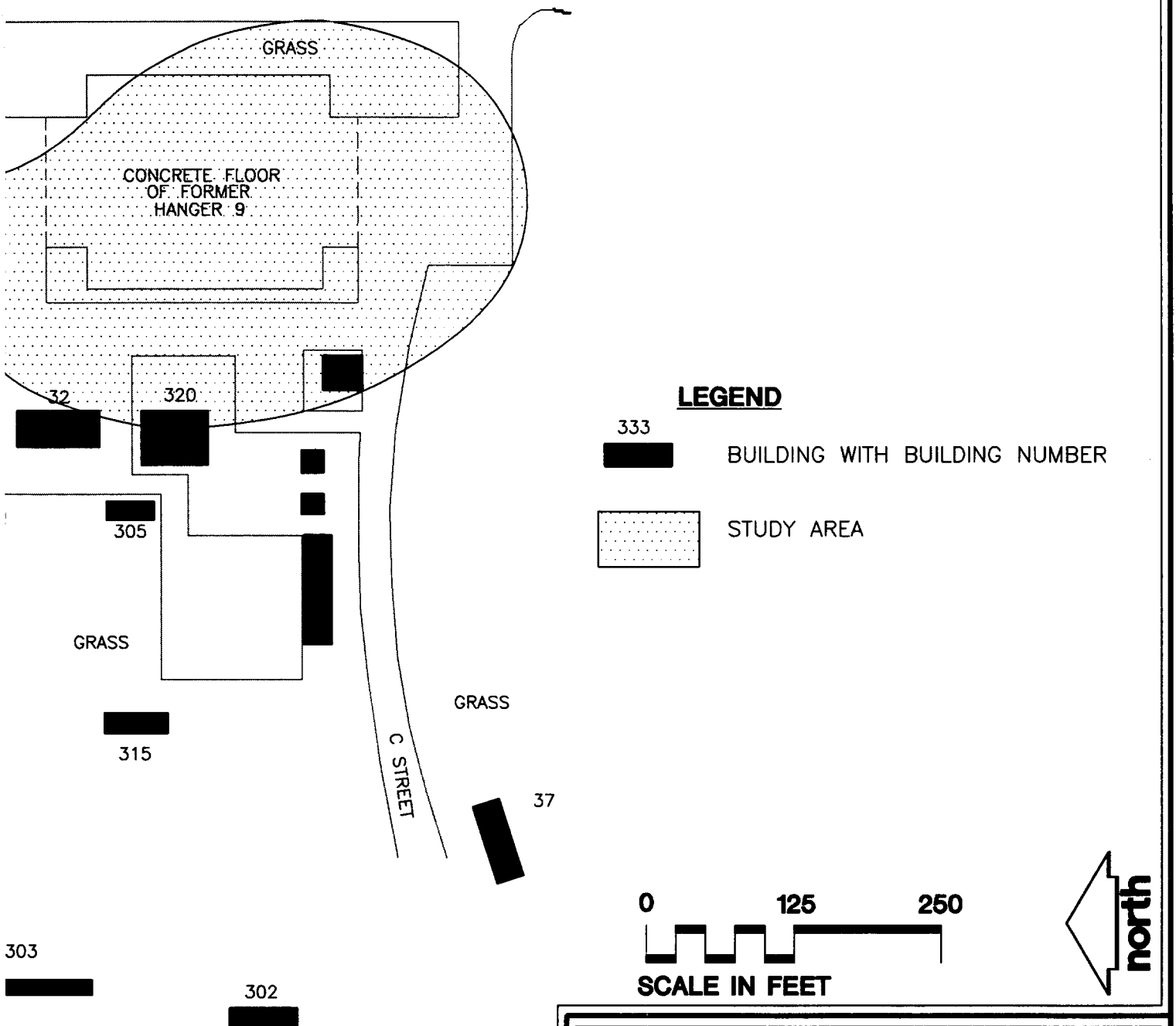
MICHIGAN AIR NATIONAL GUARD
ALPENA CRTC
ALPENA, MICHIGAN

SITE 6 AND SITE 7
SITE FEATURES MAP

FIGURE 1-6

MONTGOMERY WATSON


APRON
10
28
33
23
GRASS
HERCULES AVE/THIRD AVE
320
32
324
325
322
305
333
"F" STREET
CHOW ALLEY
GRASS
308
307
306
315
GRASS
GRASS
303
304

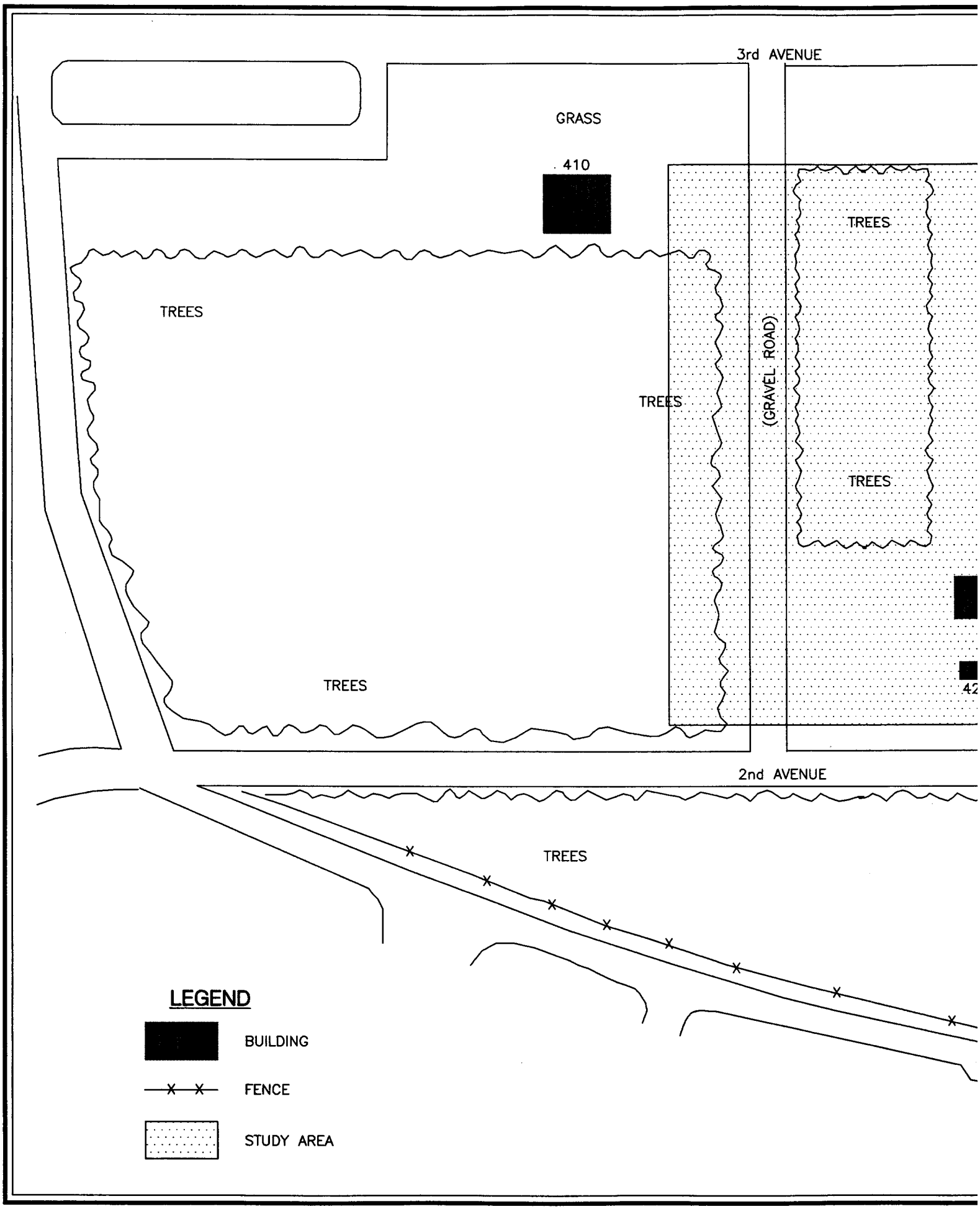


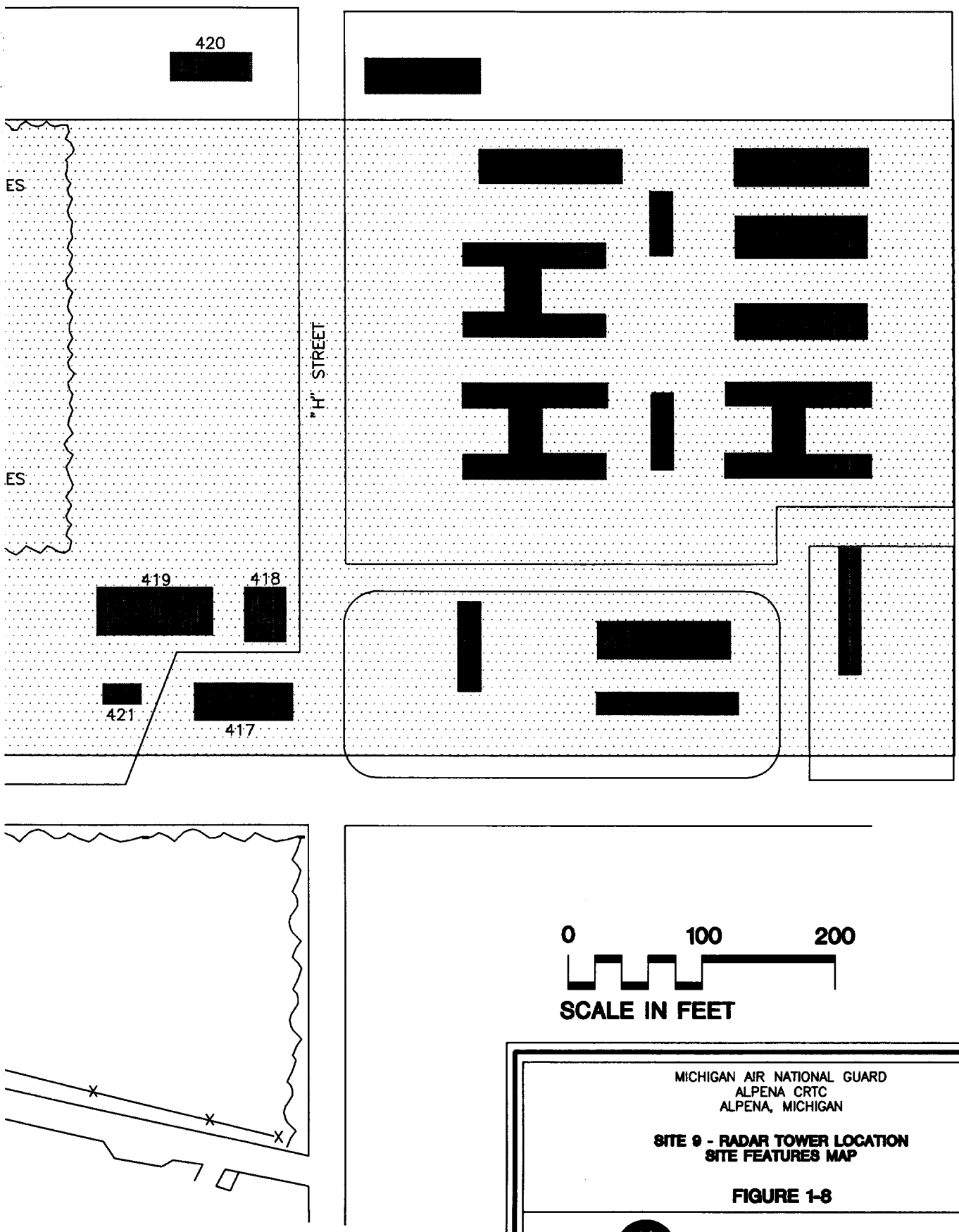
MICHIGAN AIR NATIONAL GUARD
ALPENA CRTC
ALPENA, MICHIGAN

SITE 8 - FORMER SITE HANGER 9
SITE FEATURES MAP

FIGURE 1-7

MONTGOMERY WATSON


3rd AVENUE
GRASS
410
TREES
TREES
TREES
(GRAVEL ROAD)
TREES
TREES
42
2nd AVENUE
TREES
LEGEND
BUILDING
FENCE
STUDY AREA



MICHIGAN AIR NATIONAL GUARD
ALPENA CRTC
ALPENA, MICHIGAN

SITE 9 - RADAR TOWER LOCATION
SITE FEATURES MAP

FIGURE 1-8

MONTGOMERY WATSON

1.2.3.6 Site 9 - Radar Tower Site. SI activities at Site 9 included the installation and sampling of monitoring wells, and the collection and analysis of soil samples. Surface geophysical surveys were completed in 1992 as part of the RI activities. A soil organic vapor (SOV) survey was completed in 1993. Soil boring installation, monitoring well installation, and soil and groundwater sampling and analysis comprised the remainder of the RI field activities.

1.2.4 Nature and Extent of Contamination

The media investigated at the Alpena CRTC included soil, sediment, and groundwater. Several rounds of sampling were completed from 1987 until 1993. The RI Report includes a more thorough discussion of the investigative results and the nature and extent of the contamination. This section briefly summarizes the information in the RI Report. Refer to the RI Report for complete details on the information presented below.

1.2.4.1 Soil and Sediment. Soil samples were collected from all six of the Alpena CRTC sites included in this FS. Sediment samples were collected at Site 1 and Sites 6 and 7. The samples were analyzed for impacts (volatile organic compounds [VOCs], semi-volatile organic compounds [SVOCs], and metals) potentially caused by past operations at the Alpena CRTC. Samples taken from each site contained minimal detections that are likely due to base operations.

1.2.4.2 Groundwater. Groundwater samples were collected from all six of the Alpena CRTC sites. The groundwater samples were evaluated to determine if the groundwater contains contamination caused by past operations at the Alpena CRTC. Four rounds of groundwater sampling were conducted at most sites between 1987 and 1993. Most of the sites were found to have minimal or no contamination in the groundwater. Section 2.4 contains information on specific contaminant type and concentrations for each site. In those sites with contamination, the data presented in the RI Report indicates that the levels of the constituents in the groundwater are diminishing with time. Relatively few groundwater samples taken at the Alpena CRTC sites during the 1993 sampling contained constituents in excess of established ARARs. This decrease in groundwater contamination concentrations is due to natural attenuation, dilution, and bio-degradation.

1.2.5 Contaminant Fate and Transport

This section provides a brief summary of the contaminant fate and transport for chemicals of potential concern at the Alpena CRTC sites. The RI Report BRA provides detailed information on the pathways for the constituents. Refer to the RI Report for complete details on the information presented below.

The release of contaminants into the environment and their subsequent transport and transformation are dependent on chemical and physical properties, such as the characteristics of the transporting media, specific chemical properties of the impacts, climatic conditions, and site-specific features.

Migration pathways define the route and method by which a chemical moves from the source to the potential receptor. Potential migration pathways for each of the Alpena CRTC sites are listed in the RI Report BRA.

Constituents at the Alpena CRTC site were detected in the soil, sediment, and groundwater. Refer to the RI Report for a complete listing of the detected constituents. VOCs, SVOCs, and metals were detected in sediments and soils although, in general, the detected levels of these constituents do not pose a threat to human health or the environment. Groundwater impacts are considered to be minimal with only a small number of constituents at levels above ARARs.

VOCs are the most mobile constituents present and are likely to migrate the farthest regardless of the media (air, soil, or groundwater).

Groundwater is the migration pathway with the greatest potential for movement of contaminants. Chemicals with mid range to high water solubility (relative to metals), low K_{oc} values (partition coefficient of a compound between organic carbon and water) and low retardation factors are more likely to migrate in the groundwater with little attenuation.

Metals in the soil will generally only migrate by advection transport through the unsaturated zone. Attenuation processes which slow the movement of metals in the soil include precipitation and sorption/desorption. In general, the metals detected above Default Background Values at the Alpena CRTC sites will tend to be absorbed or attenuated to the organic carbon content of the soil and do not pose a threat of leaching.

1.2.6 Baseline Risk Assessment

A BRA was performed during the RI to assess the risks posed to human health and the environment by the constituents detected at the Alpena CRTC sites. The complete BRA is presented in the RI Report. The following is a summary, by site, of the impacts which were estimated to pose a human health concern.

1.2.6.1 Site 1 - Petroleum, Oils, and Lubricants Storage Area. No current complete exposure pathways were identified in the RI Report for Site 1. The complete future pathways include Thunder Bay River surface water pathways (ingestion, dermal absorption and fish consumption) and shallow aquifer production well (PW3) pathways (ingestion, dermal absorption, and inhalation of VOCs). Carcinogenic and non-carcinogenic exposure risks were evaluated for all scenarios in the RI Report BRA. The report indicates that no future pathways for the on-site adult or recreational child exceed the Michigan Department of Environmental Quality (MDEQ) established cancer risk guidance level of 1×10^{-5}. Results of hazard quotient (HQ) analysis for Site 1 indicate a HQ greater than 1 for a future excavation worker due to inhalation of VOCs from subsurface soil. The HQ above 1 indicates an unacceptable non-carcinogenic risk for this pathway.

1.2.6.2 Site 3 - Former Site of County Garage. No current complete exposure pathways were identified in the RI Report for Site 3. Future complete exposure pathways were only identified for the future excavation worker, including subsurface soil ingestion and dermal contact, and inhalation of fugitive dust. Carcinogenic and non-carcinogenic exposures were evaluated for all complete pathways in the RI Report BRA. The report indicates that no future pathways exceed a

cancer risk of $1x10^{-5}$. No HQs above 1 were calculated for the excavation worker, indicating a low potential for adverse non-carcinogenic effects.

1.2.6.3 Site 5 - Second Fire Training Area. No current complete exposure pathways were identified in the RI Report BRA for Site 5. The only future exposure pathway considered complete involved fish consumption from Lake Winyah. Carcinogenic and non-carcinogenic exposures were evaluated for all complete pathways in the RI Report BRA. No future risk above $1x10^{-5}$ was calculated for the recreational adult and child consuming fish from Lake Winyah. All current HQs are below 1, indicating a low potential for adverse non-carcinogenic effects.

1.2.6.4 Sites 6 and 7 - Former Solid Waste Landfill and First Fire Training Area. No current complete exposure pathways were identified in the RI Report BRA for Sites 6 and 7. Future complete exposure pathways include Thunder Bay River surface water pathways (ingestion, dermal contact, and fish consumption) and Lake Winyah backwater sediment pathways (dermal contact and ingestion). Carcinogenic and non-carcinogenic exposures were evaluated for all scenarios in the RI Report. No future risk above $1x10^{-5}$ was calculated for any of the future complete exposure pathways except the sediment pathways. The results of the BRA indicate that exposure pathways involving the sediment in the backwater areas of Lake Winyah (ingestion and dermal contact) exceed the $1x10^{-5}$ acceptable level for both the adult and child receptors. This is based on the concentration detected in sediment sample LF6SD4. An evaluation of sediment risk estimates indicates that this conclusion was overstated.

The RI Report BRA was completed using USEPA models and exposure scenarios. Since the BRA was published, Michigan has amended Public Act (PA) 451, Part 201. The new amendments use different exposure models and exposure values to determine risks. Operational Memorandum (Op Memo) #8, Revision 4, June 1995 and Op Memo #14, Revision 2, June 1995, provide a table of predetermined concentrations for individual chemicals that would have a exposure risk of $1x10^{-5}$. A comparison can be made between the USEPA model used in the completion of the BRA and the MDEQ approved risk model by evaluating the concentrations of chemicals detected in the sediment sample (LF6SD4). The detected concentrations and the

known risk can be ratioed and the ratios added. This is a standard method used by industrial hygienists to compare different calculation methods. An added ratio value of one or greater represents a potential exposure risk in excess of $1x10^{-5}$. The detected concentrations at LF6SD4 were ratioed against values in Op Memo #8 for each detected chemical; the results are shown in Table 1-1. The summation of the ratios is 0.35. This value is less than 1 and indicates that there are no chemical-specific future cancer risks, pathway cancer risks, or total exposure cancer risk which exist above the $1x10^{-5}$ acceptable level for the sediment exposure pathways in the backwater area of Lake Winyah for both the adult and child receptors. This method uses the more conservative Residential Criteria in its evaluation, and it conservatively assumes that all chemicals target the same organs.

All chemical specific HQs are below 1 for both the adult and child receptors indicating a low potential for adverse non-carcinogenic health effects.

1.2.6.5 Site 8 - Former Site of Hangar 9. The RI Report BRA indicates that the current complete exposure pathways include the soil pathways (ingestion and dermal contact with soils). The on-site adult is the only current receptor. Future exposure pathways listed in the RI Report BRA include the above-listed soil pathways for the recreational child and future on-site/recreational adult. Additional future exposure pathways for the on-site/recreational adult and child include shallow aquifer groundwater pathways (drinking water ingestion, dermal contact, inhalation of VOCs during showering). If any future construction activities take place, then additional exposure soil pathways (ingestion, dermal contact, and inhalation of fugitive dust) become complete for the excavation worker. Carcinogenic and non-carcinogenic exposures were evaluated for all scenarios in the RI Report BRA. No future carcinogenic risk above $1x10^{-5}$ was calculated for any of the above listed pathways. No current or future HQs were determined to be above the reference level of 1.

Table 1-1
Risk Analysis Evaluation for Act 451
Alpena Combat Readiness Training Center
Alpena, Michigan

Compound	Detected Concentrations for Sediment Sample LF6SD4	$1x10^{-5}$ Residential Exposure Risk Values from PA 451	Ratio Factor Detected Concentration/ Exposure Risk Values
	ppb[(a)]	ppb	
Anthracene	460	4.20E+08	0.0000
Benzo(a)anthracene	450	1.40E+04	0.0321
Benzo(a)pyrene	320	1.40E+03	0.2286
Benzo(b)fluoranthene	690	1.40E+04	0.0493
Benzo(ghi)perylene	61	1.50E+06	0.0000
Benzo(k)fluoranthene	690	1.40E+05	0.0049
Butyl benzyl phthalate	66	6.80E+07	0.0000
Chrysene	430	1.70E+04	0.0253
Di-n-butylphthalate	64	5.10E+07	0.0000
Fluoranthene	460	5.10E+07	0.0000
Indeno(1,2,3-cd)pyrene	120	1.40E+04	0.0086
Phenanthrene	460	1.50E+06	0.0003
Pyrene	420	3.20E+07	0.0000
Sum of Risk Ratio			**0.3492**

(a) ppb=part per billion

1.2.6.6 Site 9 - Radar Tower Site. No current complete exposure pathways were identified in the RI Report BRA for Site 9. Future complete exposure pathways are those related to groundwater (ingestion, dermal contact, and inhalation of VOCs) for the recreational child and on-site/recreational adult. Carcinogenic and non-carcinogenic exposures were evaluated for all scenarios in the RI Report BRA. No future carcinogenic risks above $1x10^{-5}$ were calculated for any of the above listed pathways. No current or future HQs were determined to be above the reference level of 1.

1.2.6.7 Conclusion. Based on an analysis of the RI Report BRA, Site 1 is the only site with a risk based human health concern. Subsurface soils at Site 1 have an unacceptable non-cancer risk from inhalation of VOCs by future construction workers.

2.0 REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

This section discusses the identification of the ARARs, the development of the RAOs and GRAs, and preliminary screening of technologies.

2.1 INTRODUCTION

The first step in the FS process is the determination of the ARARs, the development of the RAOs, and the identification of the GRAs. RAOs consist of medium-specific or site-specific goals for protecting human health and the environment. GRAs describe those remedial actions that satisfy RAOs.

The next step in the FS process is the identification and screening of remedial technologies. Each technology is screened based on effectiveness, implementability, and relative cost for the soil and groundwater contamination identified at the Alpena CRTC.

By direction of the ANG/CEVR, this FS report has been streamlined by generalizing the preliminary sections of the report. The identification of the ARARs, the development of the RAOs and GRAs, and the technology identification and screening are presented in this section and discussed in general for media specific categories (i.e., soil and groundwater).

The identification of the ARARs is presented in Section 2.2, the development of the RAOs is presented in Section 2.3, the identification of the GRAs in presented in Section 2.4, and the screening of technologies and alternatives is presented in Section 2.5. The analysis in each of these sections is based on the media specific categories.

2.2 PRELIMINARY IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs are environmental and public health statutes used in identifying site impacts which may pose human health or environmental concerns at a site. CERCLA, as amended by SARA, and the National Contingency Plan (NCP) require compliance with ARARs.

The state of Michigan does not have an alternate definition of ARARs; therefore, the definition based on federal guidelines is presented below. According to the NCP (contained in Title 40 of the Code of Federal Regulations, Part 300), "applicable" and "relevant and appropriate" are defined as follows:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility citing law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

- Relevant and appropriate requirements are those cleanup standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility citing law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate.

Neither SARA nor the NCP provides across the board standards for determining whether a particular remedy provides adequate cleanup at a particular site. Rather, the process recognizes that each facility has unique characteristics that must be evaluated and compared to those requirements that apply under the given circumstance.

SARA also requires attainment of state ARARs if they are more stringent than federal ARARs, legally enforceable, and consistently enforced statewide. In the state of Michigan, PA 451 provides guidance for determining the appropriate remedial actions at contaminated sites.

The ARARs are identified and considered at the following steps in the remedial process:

- As part of the remedial investigation/feasibility study (RI/FS) scoping
- During the site characterization phase of the remedial investigation (RI)
- During the development of remedial alternatives
- During detailed analysis of remedial alternatives
- When an alternative is selected
- During the remedial design

There are three general types of ARARs with which remedial actions must comply: action-specific; chemical-specific; and location-specific. Each type is explained below.

Action-specific ARARs are technology or activity based requirements or limitations placed on remedial activities. There are several action-specific requirements that may apply to the sites, depending on the determined remedial action of the site. For example, emitting off-gasses from remedial control technologies would have specific limitations which would need to be met. Additional considerations may include obtaining a construction permit if a treatment building is to be constructed on-site or the potential for requiring land use restrictions and right of way permits.

Chemical-specific ARARs are health or risk based concentration limits or limits specified by methodologies for various environmental media (i.e., groundwater, air, or soil) that are established for a specific chemical. These cleanup goals establish the acceptable amount or concentration of a chemical that may remain in, or be discharged to the ambient environment. If a chemical has more than one cleanup standard, the most stringent standard is established as the ARAR for that chemical. The chemical-specific ARARs for the media of concern are discussed in the following sections.

Location-specific ARARs are restrictions placed on a site solely due to the location of the site. Examples of special locations possibly requiring ARARs include wetlands, flood plains, sensitive ecosystems, critical habitats of threatened and endangered species, historic places, and

archaeological sites. These locations are special due to the presence of important geographical features, biological features, or cultural resources.

2.2.1 ARARs for Soils

The following is a list of potential ARARs that were considered in the evaluation of the soils at the Alpena CRTC:

2.2.1.1 Action-Specific ARARs. The following are action-specific ARARs that are potentially applicable to the soils based on activities or technologies required for remediation activities.

- Soil Erosion and Sedimentation Control Act (PA 347, 1972). Sites requiring excavation during remedial actions may require a permit under PA 347 due to the Alpena CRTC's proximity to the Thunder Bay River and Lake Winyah.

- Michigan Air Pollution Act of 1965, PA 348. Sites requiring excavation during remedial action or technologies with off-gas streams may require a permit under PA 348 due to emissions of VOCs and or particulates.

2.2.1.2 Chemical-Specific ARARs. The following are chemical-specific ARARs based on current MDEQ guidelines for remediation of soils.

- Default Statewide Background Values (Default Background Values) as specified by the Michigan Environmental Response Act (MERA) Op Memo #15, September 30, 1993. These criteria represent allowable default background concentrations to be used in the evaluation of sites in Michigan. These values were used in this FS as guidance in evaluating soil impacts, but were not used as mandatory cleanup levels when no risk to human health or the environment was identified at a site.

- Generic Industrial or Commercial Cleanup Criteria for Soil Direct Contact Value (Industrial Direct Contact Values) as specified by Michigan PA 451, Part 201, as outlined

in the MERA Op Memo #14, Revision 2, June 6, 1995. These criteria have been developed by the MDEQ utilizing specific risk and exposure algorithms intended to simulate industrial and commercial land use activity. When direct human contact with the soil is anticipated, the Industrial Direct Contact Values are used as an ARAR to ensure that levels in soil are protective of human health. The Alpena CRTC is categorized as a subcategory II commercial land use facility as defined in Op Memo #14. Under MDEQ guidelines, subcategory II commercial facilities use the Industrial Criteria for evaluation of soil impacts. Therefore, the evaluation of the soil at the Alpena CRTC sites was based on the Industrial Criteria presented in Op Memo #14.

- Generic Industrial or Commercial Cleanup Criteria for soil to be considered protective of groundwater as specified by Michigan PA 451, Part 201, as outlined in the MERA Op Memo #14, Revision 4, June 6, 1995. The determination of a constituent concentration protective of groundwater can be accomplished several ways: 1) through the use of a leach test; 2) by comparison with 20 times the appropriate health based drinking water criterion (20 times the Industrial Drinking Water Values); or 3) by use of fate and transport modeling or perched in-situ groundwater evaluation, that demonstrates that hazardous substances in soil will not result in impacts to groundwater over criteria. Soil must be shown protective of groundwater for sites in which groundwater is used as a source of drinking water. The Alpena CRTC does not currently use and has no future plans for using the groundwater in the impacted unconsolidated formation as a source of drinking water. However, since the groundwater beneath the base is an aquifer which could potentially be used as a drinking source in the future, soils at the Alpena CRTC were evaluated under this criteria to verify that they are protective of groundwater.

2.2.1.3 Location-Specific ARARs. The following is a list of location-specific ARARs that are considered potentially applicable to the Alpena CRTC.

- Floodplain Encroachment Act (PA 167, 1968). Sites requiring excavation during remedial actions may require a permit under PA 167 due to the Alpena CRTC's proximity to the Thunder Bay River and Lake Winyah.

- Michigan Wetlands Protection Act of 1979, Public Act 203. Sites requiring excavation during remedial actions may require a permit under PA 203 due to the Alpena CRTC's proximity to the Thunder Bay River and Lake Winyah.

2.2.2 ARARs for Groundwater

The following is a list of potential ARARs that were considered in the evaluation of the groundwater at Alpena:

2.2.2.1 Action-Specific ARARs. The following are action-specific ARARs that are potentially applicable to the groundwater based on activities or technologies required for remediation activities.

- Michigan Air Pollution Act of 1965, PA 348. Technologies with off-gas streams may require a permit to discharge off-gases to the atmosphere.

- Michigan Public Act 451, Part 31, Water Resources Protection, February 1995. These regulations govern discharges of pollution to waters of the state. PA 451, Part 31 states that it is unlawful for any person directly or indirectly to discharge into the waters of the state any substance which is or may become injurious to public health, safety, or welfare. These include direct or indirect discharge to lakes and streams, injection into groundwater, and storm sewer discharges. These rules also apply to flood plains. Disposal of water to either a surface water body or to the groundwater will require a permit.

2.2.2.2 Chemical-Specific ARARs. The following are chemical-specific ARARs based on current MDEQ guidelines for remediation of groundwater.

- Federal Maximum Contaminant Levels (MCLs), as specified under the current federal maximum contaminant levels for drinking water, are established under the Safe Drinking Water Act (40 CFR Part 141).

- Generic Industrial or Commercial Cleanup Criteria for Health Based Drinking Water Value (Industrial Drinking Water Values) as specified by Michigan PA 451, Part 201 as outlined in the MERA Op Memo #14, Revision 2, June 6, 1995. These criteria have been developed utilizing specific risk and exposure algorithms intended to simulate industrial and commercial land use activity. The Alpena CRTC is categorized as a subcategory II commercial land use facility as defined in Op Memo #14. Therefore, the Alpena CRTC groundwater was evaluated under this ARAR based on the Industrial Criteria.

- Generic Industrial or Commercial Criteria Groundwater Surface Water Interface (GSI) as specified by Michigan PA 451, Part 201, as outlined in the MERA Op Memo #14, Revision 2, June 6, 1995. The GSI values define the maximum allowable hazardous substance concentration at the interface between groundwater and surface water or at the edge of the mixing zone, whichever is applicable for a specific site. Industrial GSI values were used in the evaluation of the groundwater at Alpena CRTC sites.

2.2.2.3 Location-Specific ARARs. No location-specific ARARs are considered to be potentially applicable to groundwater remediation at Alpena CRTC.

2.3 IDENTIFICATION OF REMEDIAL ACTION OBJECTIVES

As defined by the USEPA, RAOs consist of goals for protecting human health and the environment (USEPA, 1988). The RAOs identified in this section serve as guidelines for the development and evaluation of remedial alternatives.

2.3.1 Development of RAOs for Soils

The RAOs for soils are goals for protecting human health and the environment, preventing or minimizing exposure to contaminants, and achieving compliance, where possible, with ARARs. The following is a list of the RAOs for soils at the Alpena CRTC facility.

- Achieve levels of impacts in site soils that are consistent with requirements of Michigan PA 451, Part 201 for a subcategory II commercial land use facility.

- Minimize impacts to groundwater caused by impacted soils.

- Prevent human health exposure to impacted soil that could be harmful to human health.

2.3.2 Development of RAOs for Groundwater

RAOs for groundwater are goals for protecting human health and the environment, preventing or minimizing exposure to contaminants and achieving compliance, where possible, with ARARs. The RAOs for groundwater include the following:

- Achieve levels of impacts in site groundwater consistent with requirements of Federal MCLs, and Michigan PA 451, Part 201 for a subcategory II commercial land use facility.

- Prevent human health exposure to impacted groundwater that could be damaging to human health.

2.4 IDENTIFICATION OF GENERAL RESPONSE ACTIONS

In accordance with CERCLA guidance, once the RAOs for a site have been established, the next step in developing remedial measures is to identify GRAs that may be taken to satisfy the RAOs. Response actions are selected on the basis of their applicability to the characteristics and chemicals at a given site. Some response actions may be capable of meeting all of the RAOs alone, but combinations of response actions may prove to be more effective. As a baseline comparison, the no action response action is considered and carried through to the detailed analysis step.

The GRAs also include an estimate of the volumes which may require treatment. Depending on the selected remedial alternative, some of the Alpena sites may require additional pre-design testing to verify the extent of the contamination in the soil and/or groundwater. For purposes of completing this FS and for evaluating remedial alternatives, assumptions have been made as to the extent of the contamination. Volume estimates in this section are therefore preliminary.

2.4.1 GRAs for Soils

The GRAs for soils requiring remediation are listed below:

- No Action - Under the no action general response the current state of the soil is unchanged.

- Limited Action (Natural Attenuation, Monitoring, Institutional Controls) - The limited action general response is typically enacted to prevent access to or use of contaminated soil until cleanup levels are met by natural attenuation and/or treatment.

- Containment - The containment response includes technologies that involve little or no treatment, but provide protection to human health and the environment by reducing the mobility of the constituents in the soil and preventing human exposure to the constituents.

- In-situ Soil Treatment - In-situ soil treatment options remediate contaminated soil without excavating the soil.

- Aboveground Soil Treatment - Under this treatment option, soil is excavated and treated aboveground. Treated soil is either returned to the excavation location or disposed in a suitable landfill.

- Soil Excavation and Disposal - Under this option, soil is excavated and disposed either in an on-site or off-site landfill suitable for receiving the contaminated soil.

Several criteria were evaluated in determining the sites that may require remedial activities for the soil. The constituents detected in the soil were compared to the chemical-specific ARARs identified in Section 2.2.1.2 to determine if constituents pose a threat to human health. The results of the RI Report BRA were also considered in determining if constituents in the soil pose a human health risk. If either of these criteria indicated that the levels of the constituents detected in the soil are unacceptable, then remedial alternatives were developed for the site.

In addition, the constituents detected in the soil were evaluated to determine if the soil is protective of groundwater, or if the detected constituents pose a threat of leaching to groundwater. Although the groundwater at the Alpena CRTC is not currently used and there are no future plans to use the groundwater as a drinking water source, the detected constituents in the soils were compared to the Op Memo #14 guidance on protection of groundwater, (summarized in Section 2.2.1.2) to identify chemicals of concern for protection of groundwater. The Op Memo #14 guidance was used because the groundwater is in an aquifer which could be used as a drinking water source in the future. The detected concentrations of metals in the soil were compared to Default Background Values to identify chemicals of potential concern (COPCs) for

groundwater protection. Since there are no default background levels for organic constituents, the organic constituents were compared to 20 times the Industrial Drinking Water Values to identify organic COPCs for groundwater protection. The constituents identified by these comparisons were then evaluated to determine if they actually posed a threat of leaching to the groundwater.

To show that the soils at the Alpena CRTC sites are protective of groundwater, an analysis was completed for the constituents identified from the comparison described above (the COPCs). If the groundwater at a site is shown not to contain the constituents identified as COPCs at levels in excess of the Industrial Drinking Water Values, then it can reasonably be concluded that leaching of the COPCs is not a concern, and the soil can be considered protective of groundwater. For example, if arsenic was detected above its Default Background Value at a site, but the groundwater sampling from the site did not show arsenic at levels in excess of regulations, then it can be concluded that the arsenic is not leaching to groundwater at levels of concern. This type of analysis is the most accurate demonstration of the actual leaching potential of the constituents in the soils at a site. No current sources were identified in the field investigation for the impacts at the Alpena CRTC sites; past operational practices are likely the main source of the soil contamination. The field sampling data for the Alpena CRTC sites covered a six year period (from 1987 to 1993), but the original impacts (sources) are assumed to have occurred 10 to 30 years prior to the soil investigation. Therefore, if the constituents in the soil had the potential to leach, groundwater contamination would have likely been detected during the six years of field investigation. In addition, detected constituents in the soil were generally found at depths near the water table, thus reducing the amount of soil that could adsorb leached constituents.

The following subsections discuss in detail the evaluation of the soil contamination at the Alpena CRTC sites. The discussion includes figures for each site showing the location and concentration of the chemicals of potential concern, and the estimated contaminated areas. Table 2-1 provides a summary of all COPCs for the soils at all of the Alpena CRTC sites.

Table 2-1
Summary of Chemicals of Potential Concern for Soil
(constituents in excess of regulatory limits)
Alpena Combat Readiness Training Center
Alpena, Michigan

	Soil Sample Locations	Detected Constituents	Depth of Detection feet (ft)	Detected Concentration parts per billion (ppb)	Default Background[1] ppb	20 Times the Industrial Drinking Water Value[2] ppb	Industrial Direct Contact Value[3] ppb
Site 1	S1SB1	Chlorobenzene	2 to 3	6,200	[4]	2,000	1.40E+07
		Styrene	2 to 3	7,800	[4]	2,000	8.30E+05
Site 3	CG3MW1	Selenium	0 to 2.5	1,500	410	[5]	2.30E+07
	CG3PZ2	Dibenzofuran	8 to 10	150	[4]	[6]	[6]
		Phenanthrene	8 to 10	1,500	[4]	1,500	1.60E+07
Site 5	SF5SB1a	Arsenic	4 to 5.5	6,800	5,800	[5]	8.30E+04
	SF5SB7	Lead	1 to 3	54,100	21,000	[5]	4.00E+05
	SF5SB10	Lead	2 to 4	44,600	21,000	[5]	4.00E+05
Site 6/7	LF6MW1	Selenium	2.5	2,000	410	[5]	2.30E+07
		Selenium	10	1,500	410	[5]	2.30E+07
	LF6SB1	Selenium	2	9,000	410	[5]	2.30E+07
		Selenium	5	1,800	410	[5]	2.30E+07
	LF6SB3	Lead	0 to 2	31,000	21,000	[5]	4.00E+05
	LG6SB5	Lead	0 to 2	40,000	21,000	[5]	4.00E+05
	FF7SB3	Selenium	0 to 2	4,800	410	[5]	2.30E+07

Table 2-1 (continued)
Summary of Chemicals of Potential Concern for Soil
(constituents in excess of regulatory limits)
Alpena Combat Readiness Training Center
Alpena, Michigan

	Soil Sample Locations	Detected Constituents	Depth of Detection feet (ft)	Detected Concentration parts per billion (ppb)	Default Background[1] ppb	20 Times the Industrial Drinking Water Value[2] ppb	Industrial Direct Contact Value[3] ppb
Site 8	HN8SB6	Antimony	0 to 2	5,100	[4]	120	1.60E+06
		Lead	0 to 2	42,600	21,000	[5]	4.00E+05
Site 9	RT9MW1	Selenium	2.5	6,000	410	[5]	2.30E+07
	RT9SB5	Selenium	3.5	2,000	410	[5]	2.30E+07
	RT9SB6	Selenium	3.5	1,100	410	[5]	2.30E+07

Notes:

1) Default Background Concentrations from Operational Memorandum #15, September 1993.
2) Values are 20 times the Industrial Drinking Water value from the Generic Industrial or Commercial Cleanup Criteria and Other Requirements, Operational Memorandum #14, June 1995.
3) Industrial Direct Contact Values from the Generic Industrial or Commercial Cleanup Criteria and other Requirements, Operational Memorandum #14, June 1995.
4) There are no Default Background Concentrations in the Operational Memorandum for this constituent. Twenty times the Industrial Drinking Water value is used for analysis of this constituent.
5) Twenty times the Industrial Drinking Water value was not used for analysis of this constituent. Operational Memorandum #15 lists a Default Background Concentration which was used in analysis of this constituent.
6) No cleanup values listed in the MDEQ guidelines for this constituent. There is currently inadequate data to develop guideline criteria.

2.4.1.1 Site 1. Based on information presented in the RI Report, the soil samples taken at Site 1 did not contain any constituents in concentrations above the Industrial Direct Contact Values.

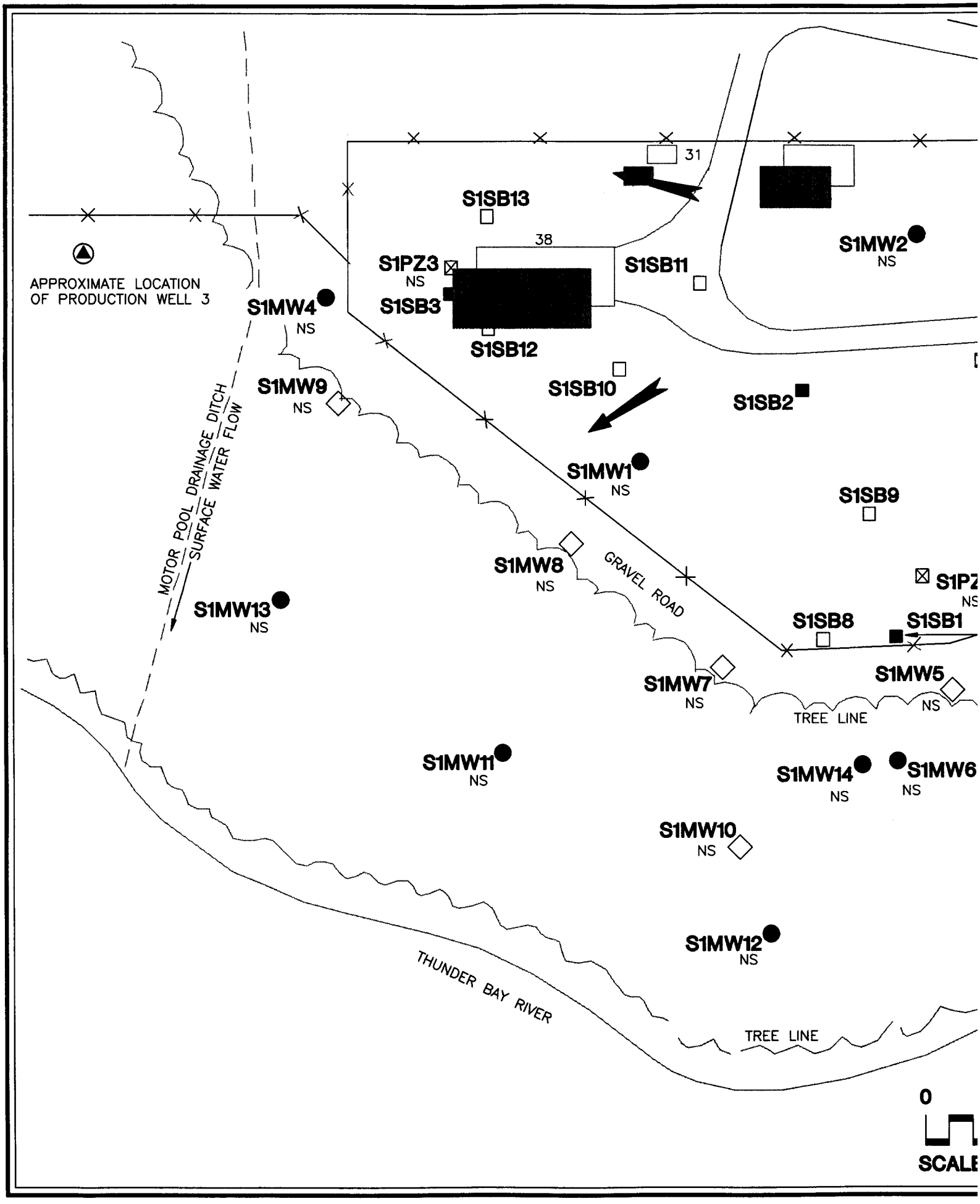
There were two organic constituents detected in sample S1SB1 at levels above 20 times the Industrial Drinking Water Values, yet these constituents were not detected in Site 1 groundwater samples above Industrial Drinking Water Values. The soil at Site 1 is considered protective of groundwater since the field investigation data for Site 1 show that the two organic soil constituents detected above the 20 times the Industrial Drinking Water Values are not present in the groundwater.

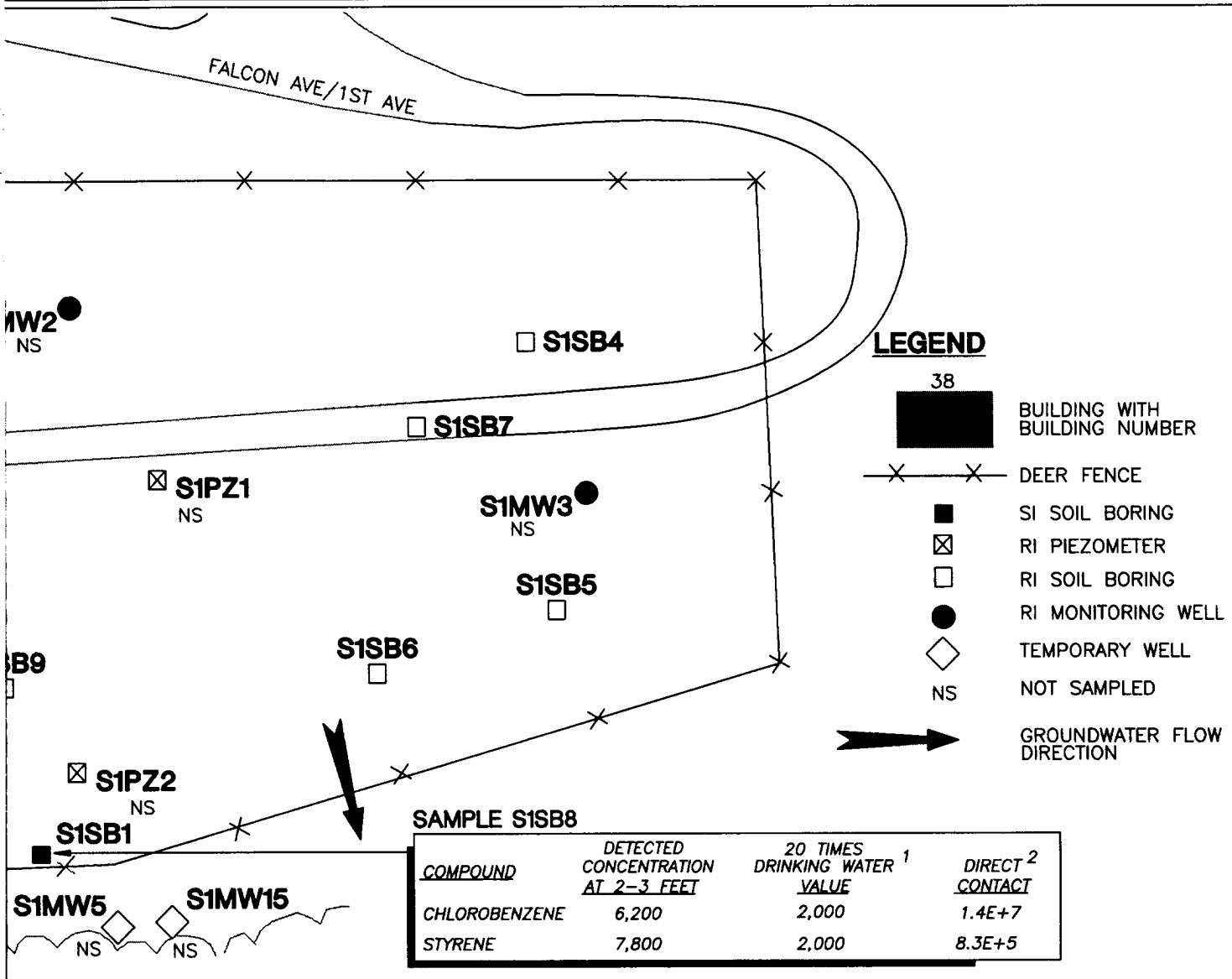
The RI Report BRA indicates that the chlorobenzene detected at sample location S1SB1 poses an unacceptable non-cancer risk to future excavation workers. Chlorobenzene is the only Site 1 soil constituent that will be considered in this FS.

The extent of impact by chlorobenzene at Site 1 has not been fully characterized. The vertical extent of the chlorobenzene at levels impacting human health is assumed to be 3.5 ft below ground surface (bgs). During field investigation, samples with chlorobenzene at levels not posing a risk to human health (delineation samples) were taken approximately 40 ft to the north, 100 ft to the east, and 220 ft to the southeast of S1SB1. In an effort to estimate the extent of the chlorobenzene, it is assumed that the contaminated soil extends halfway between the detection location and the delineation samples. The midpoints between the S1SB1 and delineation samples were connected to define the extent of the contaminated soil to the east of S1SB1. The extent of the contaminated soil on the west side is assumed to be similar to the east side.

Sediment samples taken at Site 1 did not have any impacts at levels in excess of ARARs.

Figure 2-1 shows the location of the soil sample with the detected concentrations of organic constituents exceeding 20 times the Industrial Drinking Water Values. Figure 2-2 shows the estimated extent of the contaminated soil around S1SB1. The volume of contaminated soil is estimated to be 1,900 cubic yards (cy).


APPROXIMATE LOCATION
OF PRODUCTION WELL 3
S1MW4
NS
S1MW9
NS
S1MW13
NS
S1MW8
NS
S1MW1
NS
S1MW11
NS
S1MW7
NS
S1MW10
NS
S1MW12
NS
S1MW14
NS
S1MW6
NS
S1MW5
NS
S1MW2
NS
S1PZ3
NS
S1SB13
S1SB3
S1SB12
S1SB11
S1SB10
S1SB2
S1SB9
S1SB8
S1SB1
31
38
MOTOR POOL DRAINAGE DITCH
SURFACE WATER FLOW
GRAVEL ROAD
TREE LINE
TREE LINE
THUNDER BAY RIVER
0
SCALE



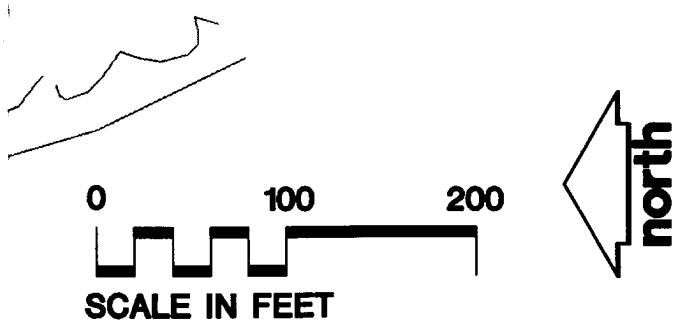
SAMPLE S1SB8

COMPOUND	DETECTED CONCENTRATION AT 2–3 FEET	20 TIMES DRINKING WATER [1] VALUE	DIRECT [2] CONTACT
CHLOROBENZENE	6,200	2,000	1.4E+7
STYRENE	7,800	2,000	8.3E+5

NOTES

1. 20 TIMES THE INDUSTRIAL DRINKING WATER VALUE FROM GENERIC INDUSTRIAL OR COMMERCIAL CLEANUP CRITERIA AND OTHER REQUIREMENTS, MDNR OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN PPB.

2. INDUSTRIAL DIRECT CONTACT VALUES FROM GENERIC INDUSTRIAL OR COMMERCIAL CLEANUP CRITERIA AND OTHER REQUIREMENTS, MDNR OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN PPB.



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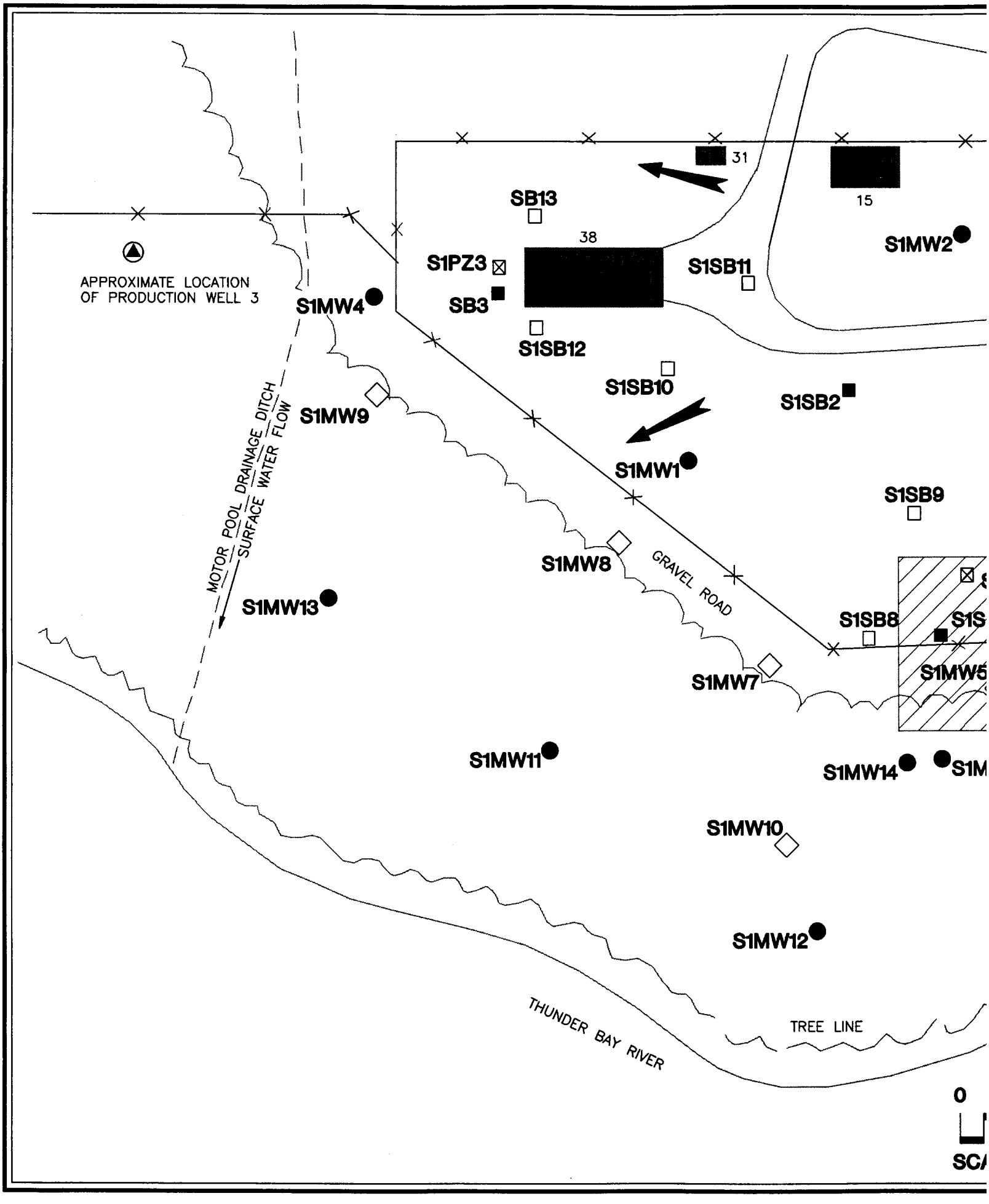
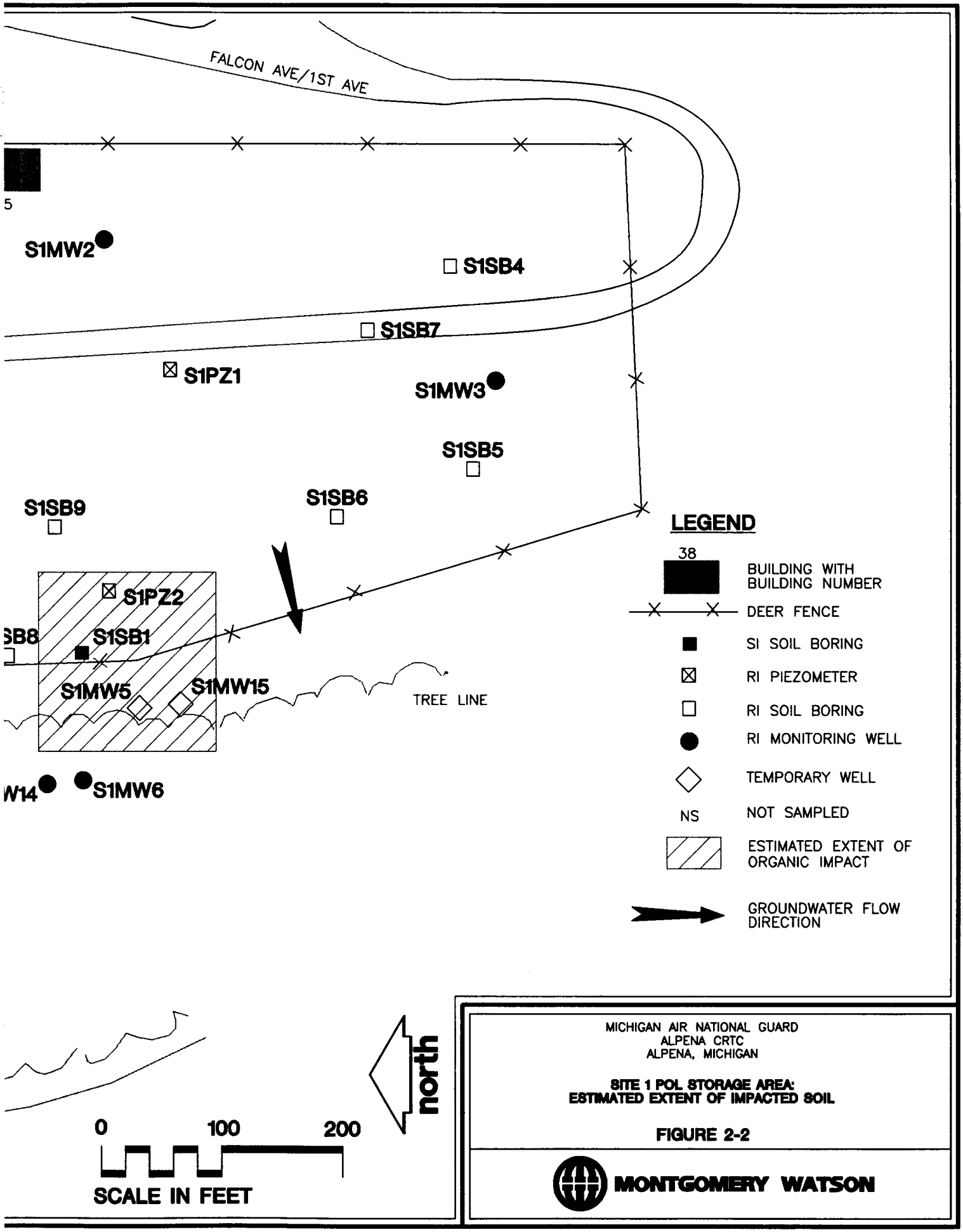
SITE 1 POL STORAGE AREA SOIL SAMPLES: CHEMICALS OF POTENTIAL CONCERN

FIGURE 2-1

MONTGOMERY WATSON


APPROXIMATE LOCATION
OF PRODUCTION WELL 3
S1MW4
S1MW9
S1MW13
S1MW8
S1MW1
S1MW7
S1MW11
S1MW14
S1MW10
S1MW12
S1MW2
S1MW5
S1PZ3
SB3
SB13
S1SB12
S1SB11
S1SB10
S1SB2
S1SB9
S1SB8
31
38
15
MOTOR POOL DRAINAGE DITCH
SURFACE WATER FLOW
GRAVEL ROAD
THUNDER BAY RIVER
TREE LINE
0



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SITE 1 POL STORAGE AREA:
ESTIMATED EXTENT OF IMPACTED SOIL

FIGURE 2-2

MONTGOMERY WATSON

2.4.1.2 Site 3. Based on information presented in the RI Report, the soil samples collected at Site 3 did not contain detected concentrations of constituents in excess of the Industrial Direct Contact Values.

There was one detected concentration of selenium above its Default Background Value in the soil samples taken from sample location CG3MW1. This constituent was not detected above Industrial Drinking Water Values in the groundwater sampled from CG3MW1, nor was it detected in downgradient wells CG3MW2 and CG3MW7. Two organic COPCs were detected at CG3SB13. Phenanthrene was detected at 20 times the Industrial Drinking Water Values. Dibenzofuran was also detected but it does not have a MDEQ criterion for comparison. Neither of these constituents was detected in the groundwater sampled from downgradient wells CG3MW3, CG3MW4, and CG3MW5. Therefore, the soil at Site 3 is considered protective of groundwater since the COPCs identified for the soil were not detected in the groundwater in excess of regulatory limits. Figure 2-3 shows the location of the soil samples with detected COPCs. The figure also gives the detected concentration of the COPCs.

There were no unacceptable risks identified in the RI Report BRA for this site.

There are no constituents in the soil at Site 3 that will be considered in this FS.

2.4.1.3 Site 5. Based on information presented in the RI Report, the concentrations of constituents in soil samples collected at Site 5 do not exceed the Industrial Direct Contact Values.

Two metals were detected at concentrations exceeding Default Background Values. Lead was detected at sample locations SF5SB7 and SF5SB10, and arsenic was detected at sample location SF5SB1a. These constituents were not detected in the groundwater samples collected at Site 5 at levels exceeding the Industrial Drinking Water Values. Specifically, no lead was detected above Industrial Drinking Water Values in monitoring well SF5MW1 (located downgradient of SF5SB7) or in SF5MW5 (located downgradient of SF5SB10). No arsenic was detected in monitoring well SF5MW5 (located downgradient of SF5SB1a). Therefore, the soil at Site 5 is

considered protective of groundwater since the COPCs identified for the soil were not detected in the groundwater in excess of regulatory limits. The locations and detected concentrations of the COPCs are shown in Figure 2-4.

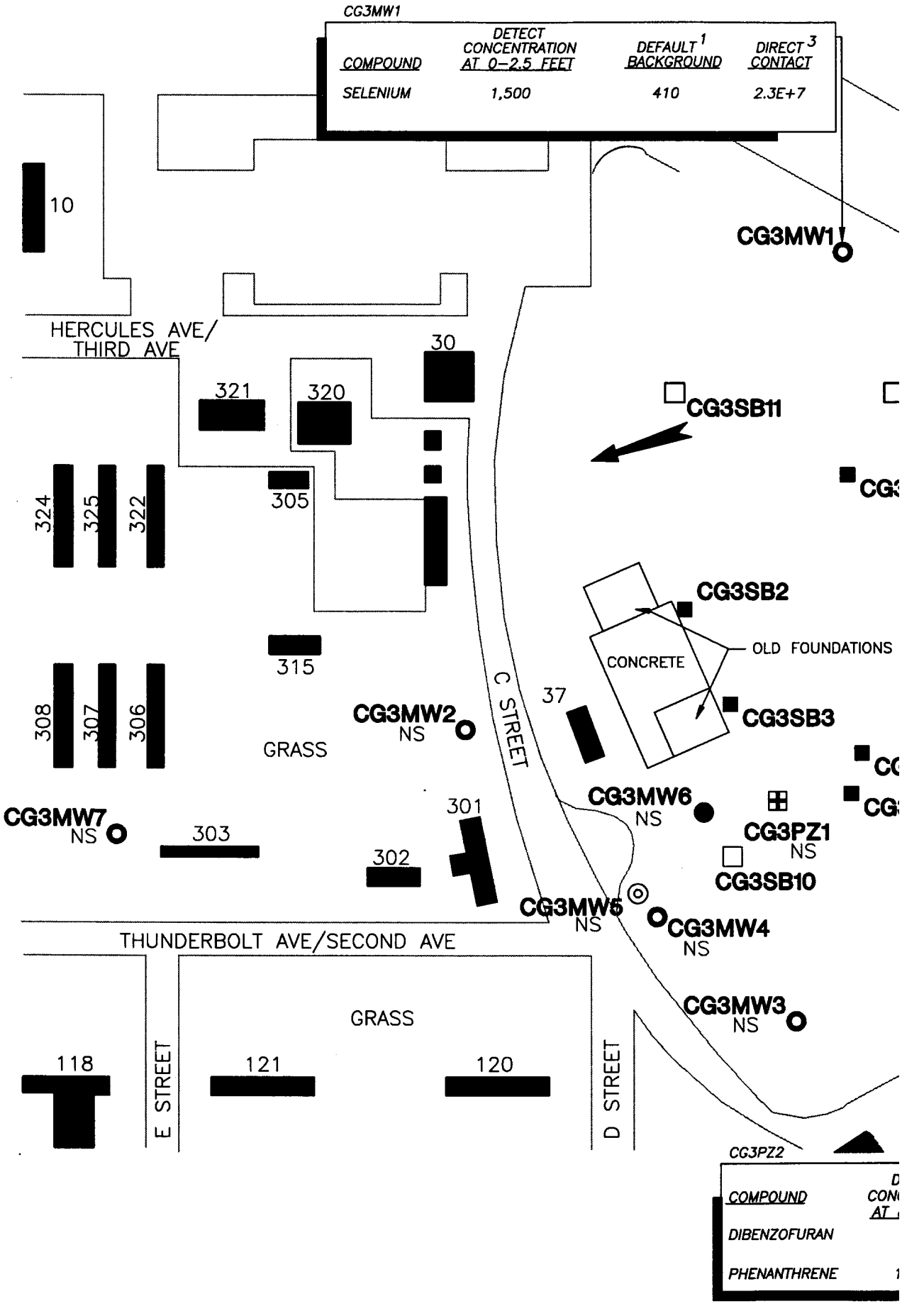
There were no unacceptable risks identified in the RI Report BRA for this site.

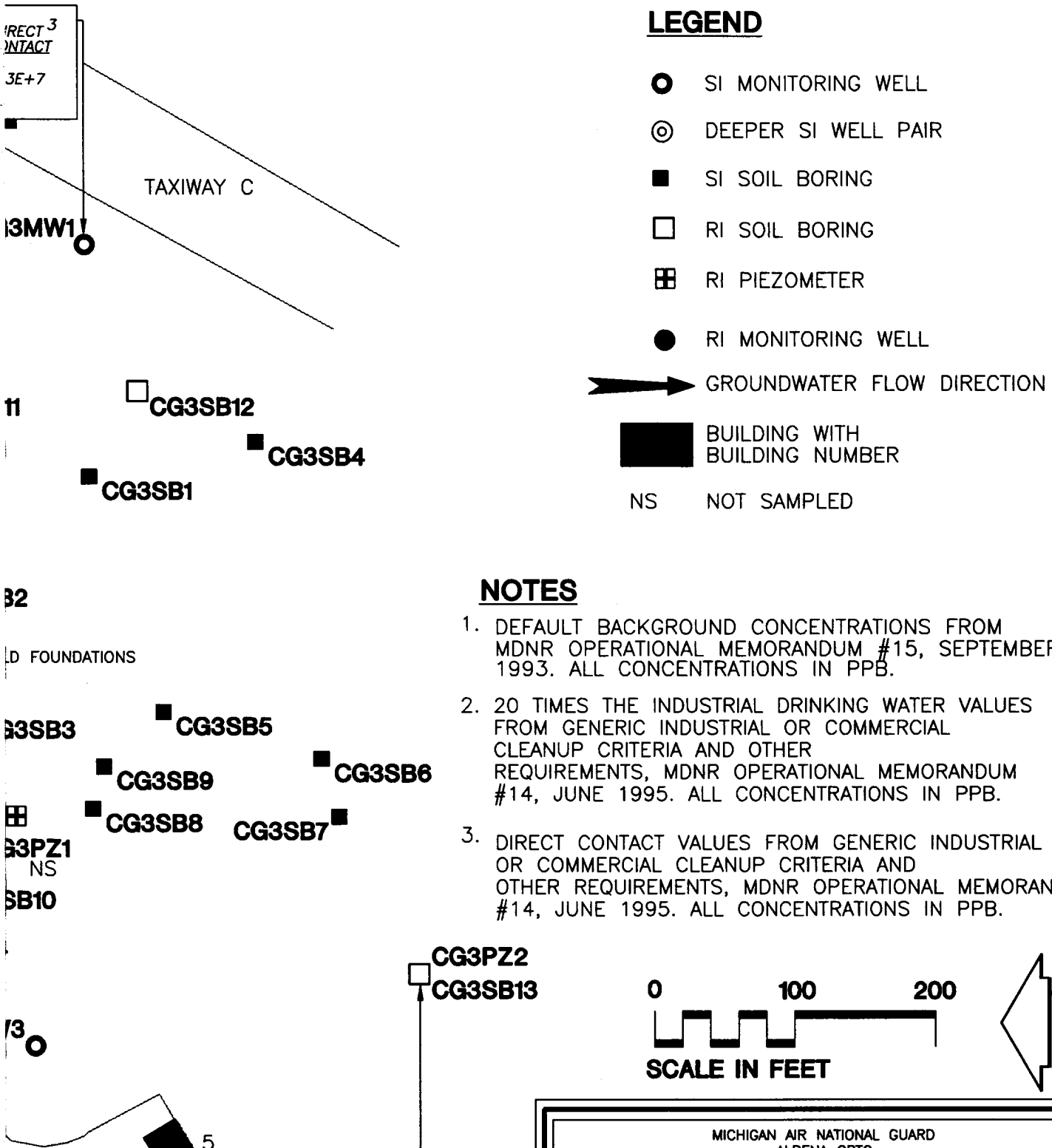
There are no constituents in the soil at Site 5 that will be considered in this FS.

2.4.1.4 Sites 6 and 7. Based on information presented in the RI Report, the concentrations of constituents detected in soil samples collected at Sites 6 and 7 do not exceed the Industrial Direct Contact Values.

Two constituents were detected in Sites 6 and 7 soil samples at concentrations exceeding Default Background Values. Selenium was detected in the soil samples from LF6MW1, LF6SB1, and FF7SB3. Lead was detected in the soil samples from LF6SB3 and LF6SB5. These constituents were not detected in the groundwater samples taken at Sites 6 and 7 at levels exceeding Industrial Drinking Water Values. Specifically, no selenium was detected above Industrial Drinking Water Values in the groundwater collected at LF6MW1. No selenium was detected above Industrial Drinking Water Values in LF6MW4 (located immediately downgradient of LF6SB1) or in LF6MW6 (located approximately 50 ft downgradient of FF7SB3). In addition, no lead was detected in samples collected at LF6MW10 or LF6MW9 (located immediately downgradient of LF6SB3 and LF6SB5, respectively). Therefore, the soil at Sites 6 and 7 is considered protective of groundwater since the COPCs identified for the soil were not detected in the groundwater in excess of regulatory limits. The locations and detected concentrations of the COPCs are presented in Figure 2-5.

The sediment samples at Sites 6 and 7 did not have any contamination at levels in excess of ARARs.


CG3MW1
COMPOUND
DETECT CONCENTRATION AT 0–2.5 FEET
DEFAULT 1 BACKGROUND
DIRECT 3 CONTACT
SELENIUM
1,500
410
2.3E+7
10
CG3MW1
HERCULES AVE/
THIRD AVE
30
321
320
CG3SB11
324
325
322
305
CG3SB2
CONCRETE
OLD FOUNDATIONS
315
37
C STREET
308
307
306
CG3MW2
NS
GRASS
CG3SB3
CG3MW6
NS
CG3MW7
NS
303
301
CG3PZ1
NS
302
CG3SB10
CG3MW5
NS
CG3MW4
NS
THUNDERBOLT AVE/SECOND AVE
GRASS
CG3MW3
NS
118
E STREET
121
120
D STREET
CG3PZ2
COMPOUND
DIBENZOFURAN
PHENANTHRENE



QUND	DETECTED CONCENTRATION AT 8-10 FEET	20 TIMES DRINKING WATER [2] VALUE	DIRECT [3] CONTACT
ZOFURAN	150	INADEQUATE DATA TO DEVELOP CRITERIA	
ANTHRENE	1,500	1,500	1.6E +7

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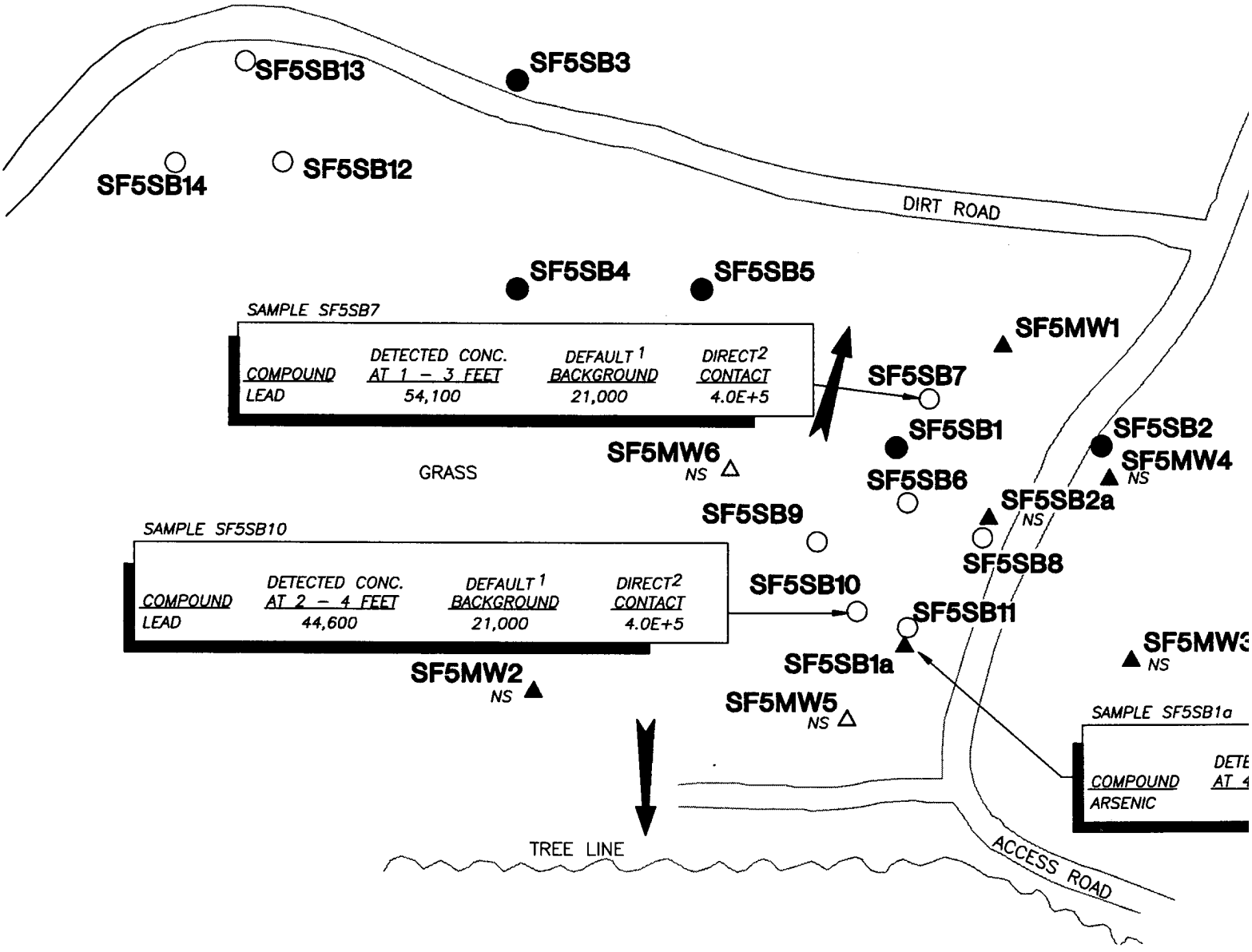
SITE 3 - FORMER SITE OF COUNTY GARAGE SOIL SAMPLES: CHEMICALS OF POTENTIAL CONCERN

FIGURE 2-3

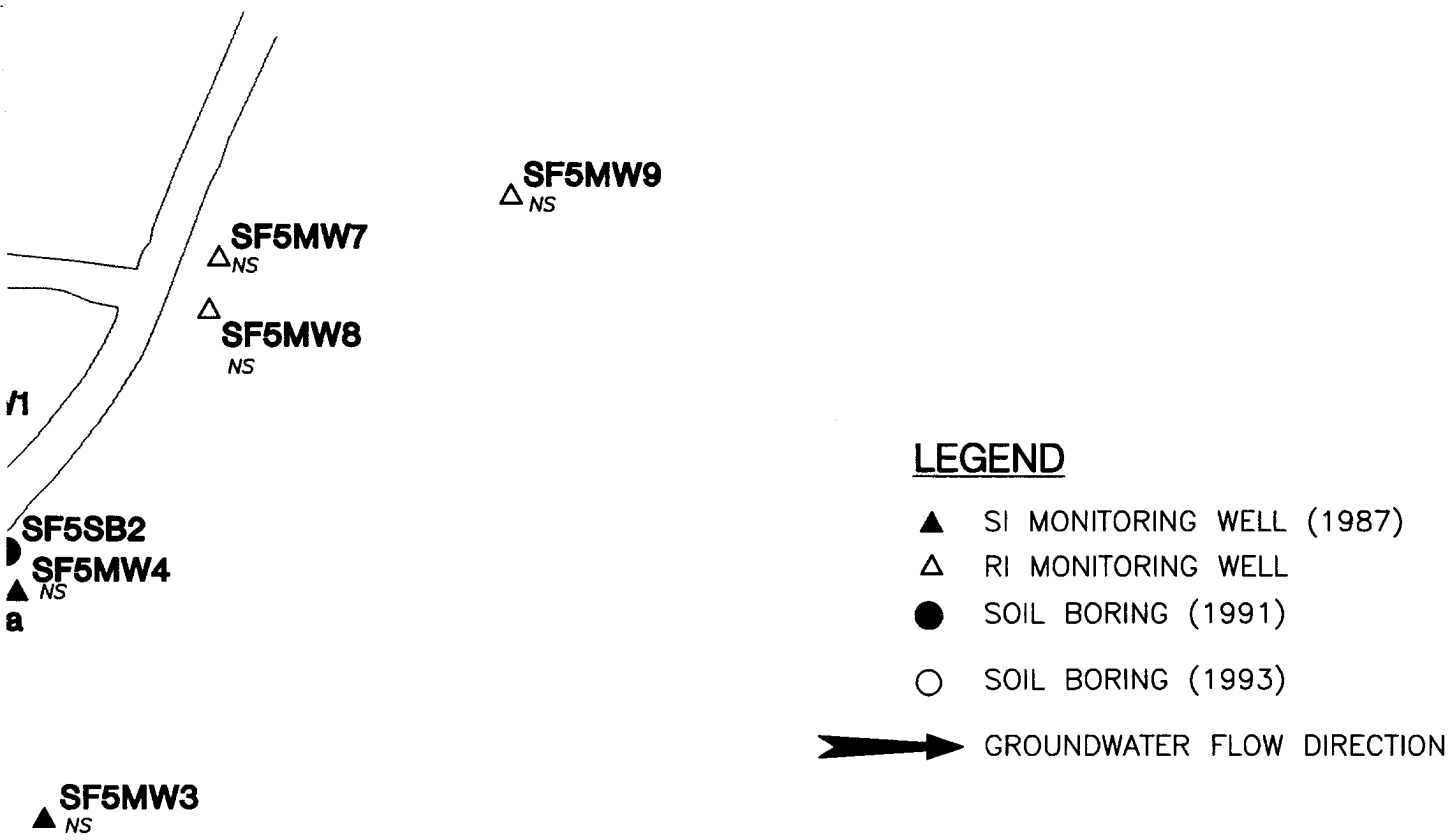
MONTGOMERY WATSON



NOTES

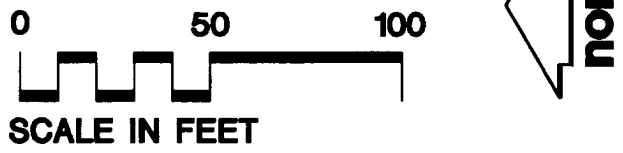
1. DEFAULT BACKGROUND CO
OPERATIONAL MEMORANDU
ALL CONCENTRATIONS IN

2. DIRECT CONTACT VALUES
OR COMMERCIAL CLEANUP
OTHER REQUIREMENTS, MI
#14, JUNE 1995. ALL CO



AMPLE SF5SB1a

OMPOUND	DETECTED CONC. AT 4 – 5.5 FEET	DEFAULT [1] BACKGROUND	DIRECT [2] CONTACT
RSENIC	6,800	5,800	8.3E+4



KGROUND CONCENTRATIONS FROM MDNR MEMORANDUM #15, SEPTEMBER 1993. TRATIONS IN PPB.

ACT VALUES FROM GENERIC INDUSTRIAL IAL CLEANUP CRITERIA AND IREMENTS, MDNR OPERATIONAL MEMORANDUM 995. ALL CONCENTRATIONS IN PPB.

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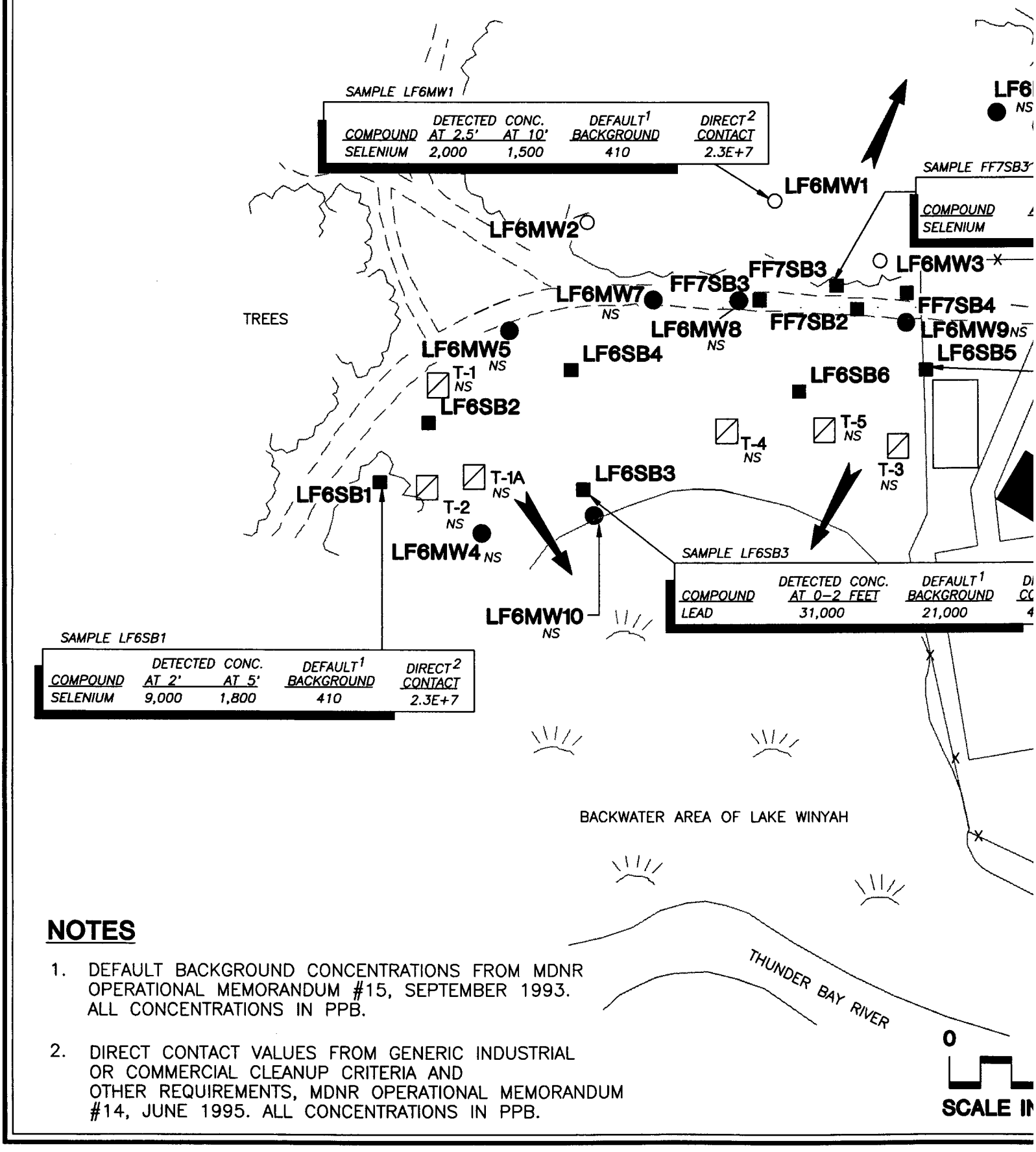
SITE 5 - SECOND FIRE TRAINING AREA: SOIL SAMPLING CHEMICALS OF POTENIAL CONCERN

FIGURE 2-4

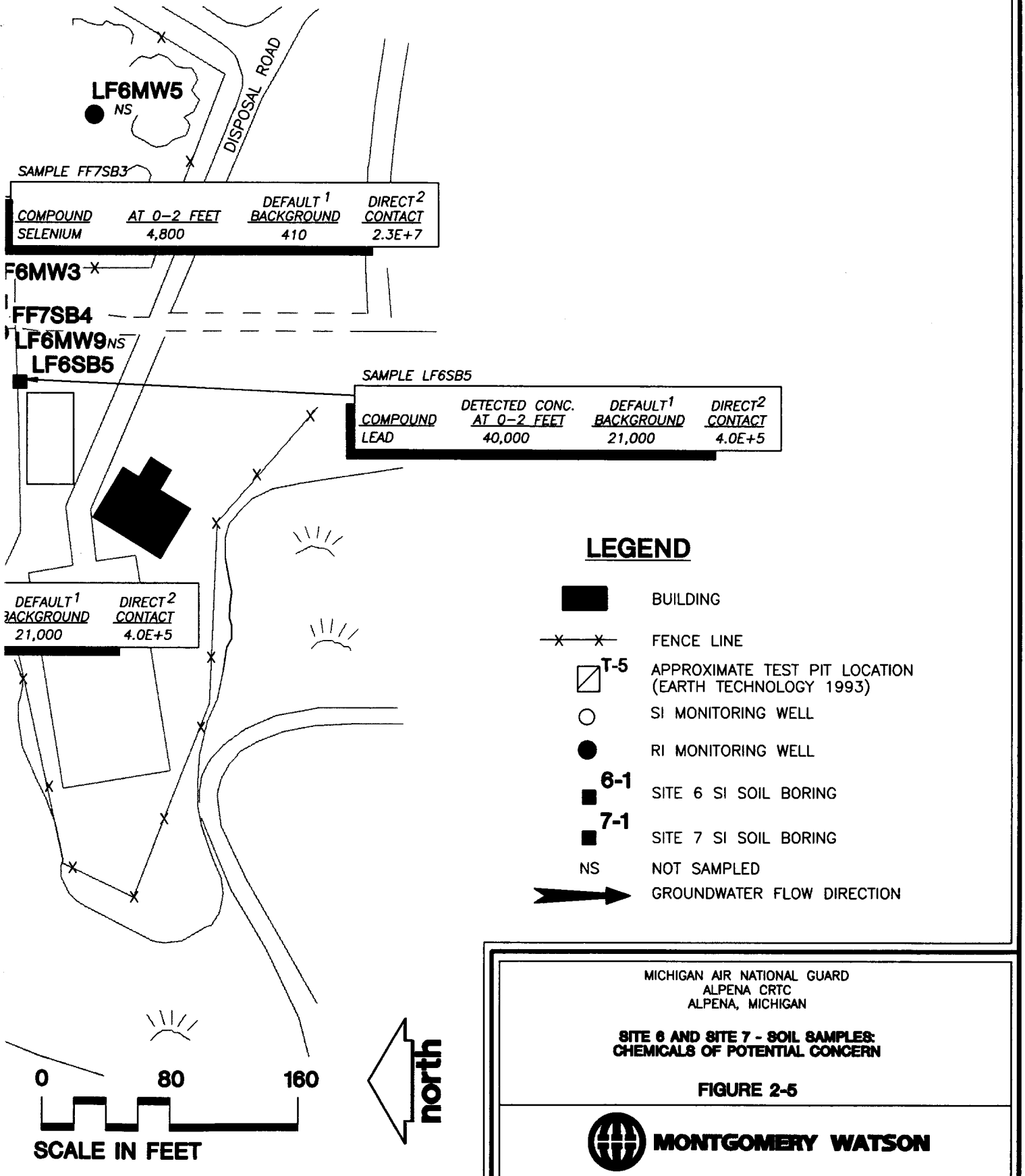
MONTGOMERY WATSON



NOTES

1. DEFAULT BACKGROUND CONCENTRATIONS FROM MDNR OPERATIONAL MEMORANDUM #15, SEPTEMBER 1993. ALL CONCENTRATIONS IN PPB.

2. DIRECT CONTACT VALUES FROM GENERIC INDUSTRIAL OR COMMERCIAL CLEANUP CRITERIA AND OTHER REQUIREMENTS, MDNR OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN PPB.



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SITE 6 AND SITE 7 - SOIL SAMPLES: CHEMICALS OF POTENTIAL CONCERN

FIGURE 2-5

MONTGOMERY WATSON

The analysis of the BRA presented in Section 1.2.6 shows that there are no unacceptable health risks at Sites 6 and 7.

There are no constituents in the soil at Sites 6 and 7 that will be considered in this FS.

2.4.1.5 Site 8. Based on information presented in the RI Report, the soil samples collected at Site 8 did not contain levels of constituents that exceeded the Industrial Direct Contact Values.

At one soil sample location (HN8SB6) antimony and lead were detected at concentrations in excess of Default Background Values. These constituents were not detected in groundwater samples collected from downgradient wells HN8MW3 and HN8MW4. Therefore, the soil at Site 8 is considered protective of groundwater since the COPCs identified for the soil were not detected in the groundwater in excess of regulatory limits. The location and detected concentrations of the COPCs are presented in Figure 2-6.

There were no unacceptable risks identified in the RI Report BRA for this site.

There are no constituents in the soil at Site 8 that will be considered in this FS.

2.4.1.6 Site 9. Based on information presented in the RI Report, the soil samples collected at Site 9 did not contain levels of constituents that exceed the Industrial Direct Contact Values.

Selenium was detected at Site 9 at concentrations exceeding the Default Background Values, yet it was not detected in groundwater samples at concentrations in excess of the Industrial Drinking Water Value. The location and detected concentration of selenium is shown on Figure 2-7.

Lead was detected in a groundwater sample (RT9MW6) at Site 9 at a concentration exceeding the Industrial Drinking Water Value. The detected concentrations of lead in soil at this site are considered within the range of base-wide background levels, and therefore, the soil is not considered the source of the groundwater contamination. The detected levels of lead in all but

one soil sample at Site 9 range between 670 to 2,600 parts per billion (ppb). These concentrations are characteristic of both the base background soil samples and the soil samples collected from the other sites. Additionally, all detected concentrations of lead from Site 9 are below the Default Background Level of 21,000 ppb. Soil sample RT9MW1 contained the highest detected concentration of lead for the Site 9 soil samples (15,000 ppb). The groundwater sampled from RT9MW1 did not contain lead in excess of the Industrial Drinking Water Values. This effectively demonstrates that lead in the soil is not impacting the groundwater. In addition, none of the other Alpena CRTC sites, all which have similar concentrations of lead in the soil, had lead contamination in the groundwater in excess of Industrial Drinking Water Values.

Based on the available information, Site 9 soil is considered protective of groundwater.

There were no unacceptable risks identified in the RI Report BRA for this site.

There are no constituents in the soil at Site 9 that will be considered in this FS.

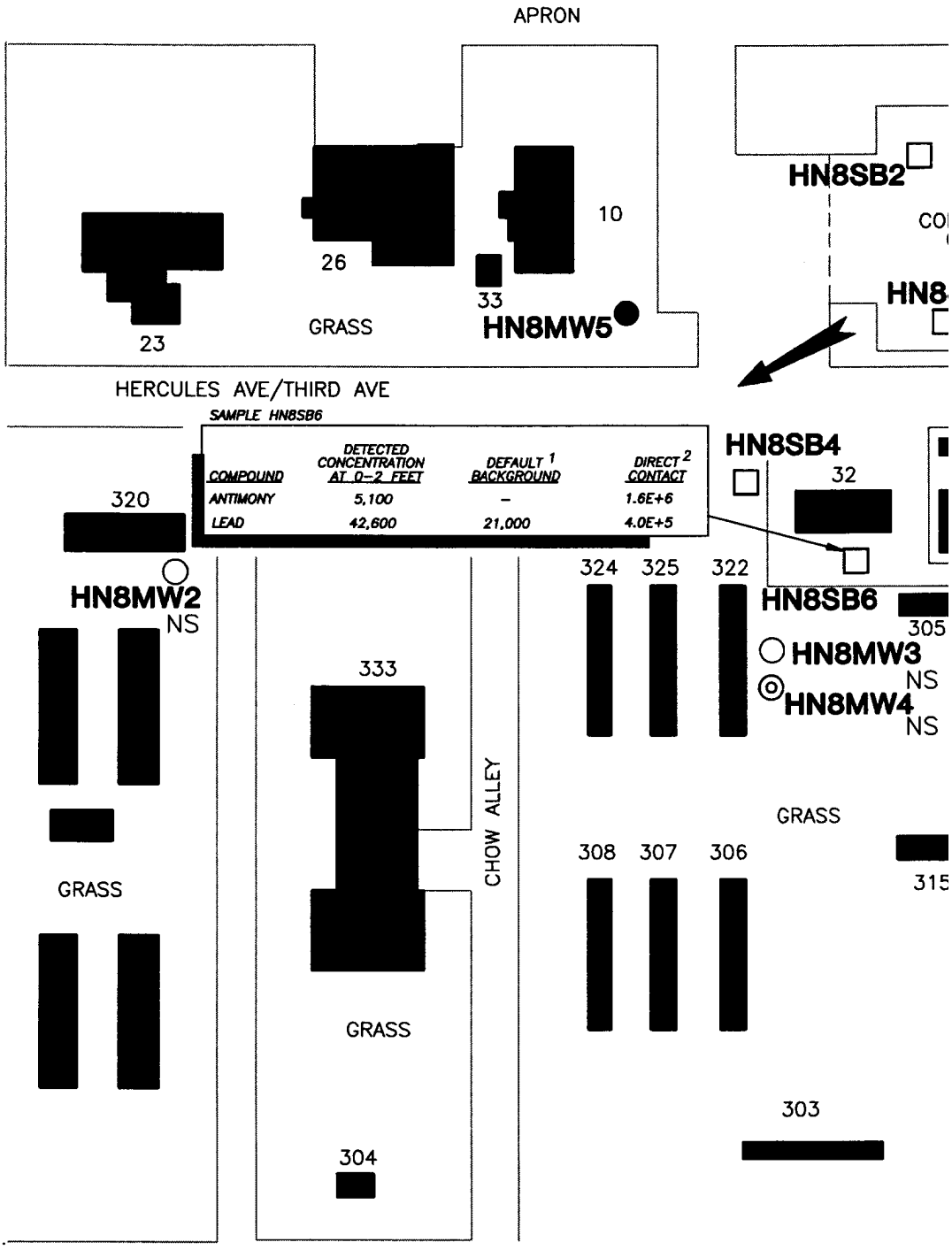
2.4.2 GRAs for Groundwater

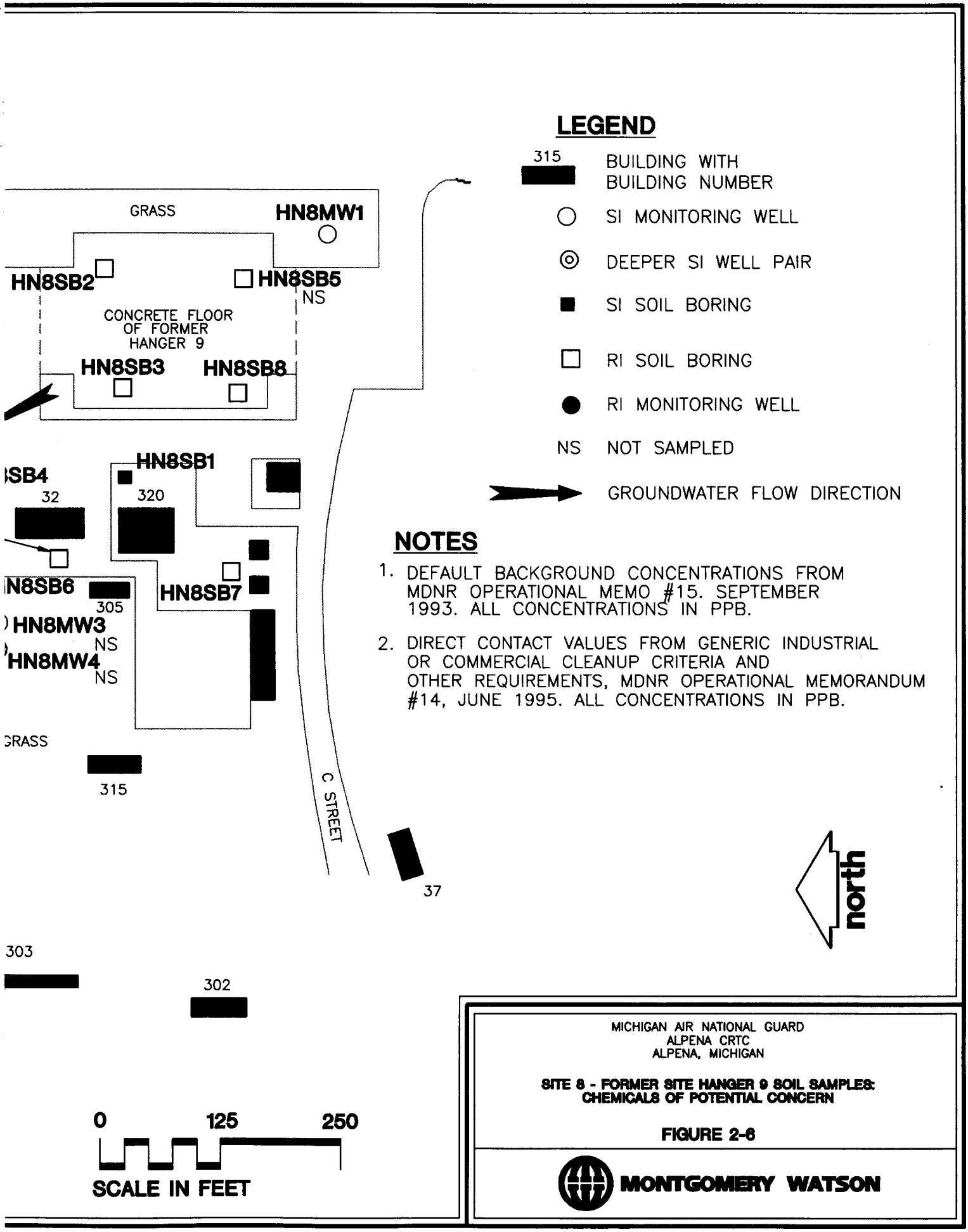
The GRAs for contaminated groundwater are listed below.

- No Action - Under the no action general response the current state of the groundwater is unchanged.

- Limited Action (Natural Attenuation, Monitoring, Institutional Controls) - The limited action general response is typically enacted to prevent access to or use of contaminated groundwater until cleanup levels are met by natural attenuation and/or treatment.

- Containment - The containment response includes technologies that involve little or no treatment, but provide protection to human health and the environment by reducing the mobility of the constituents in the groundwater and preventing human exposure to the constituents.


APRON
HN8SB2
10
26
33
23
GRASS
HN8MW5
HERCULES AVE/THIRD AVE
SAMPLE HN8SB6
COMPOUND
DETECTED CONCENTRATION AT 0-2 FEET
DEFAULT 1 BACKGROUND
DIRECT 2 CONTACT
ANTIMONY 5,100 - 1.6E+6
LEAD 42,600 21,000 4.0E+5
HN8SB4
32
320
HN8MW2
NS
324
325
322
HN8SB6
305
HN8MW3
NS
HN8MW4
NS
333
CHOW ALLEY
GRASS
308
307
306
315
GRASS
303
304
0



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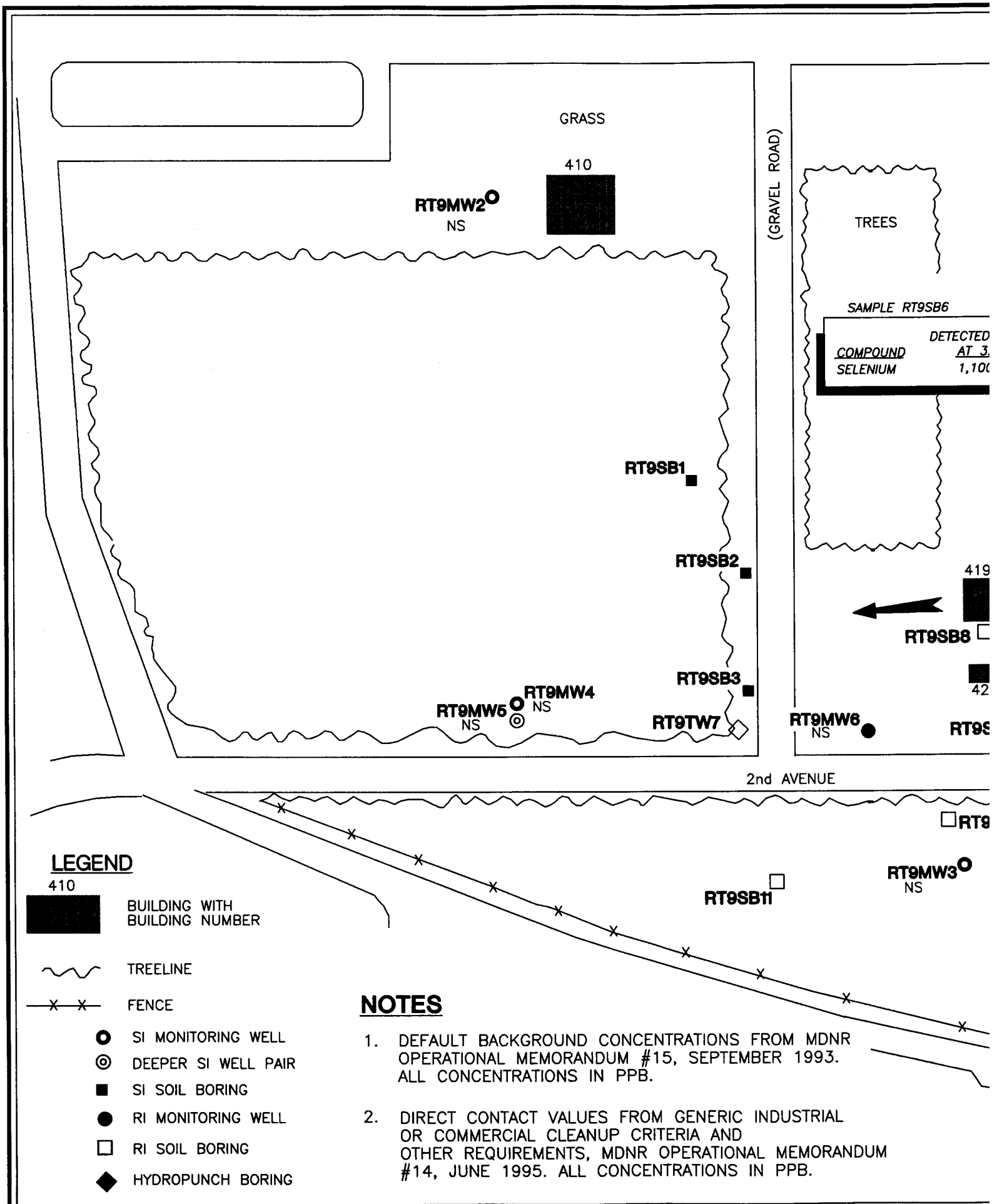
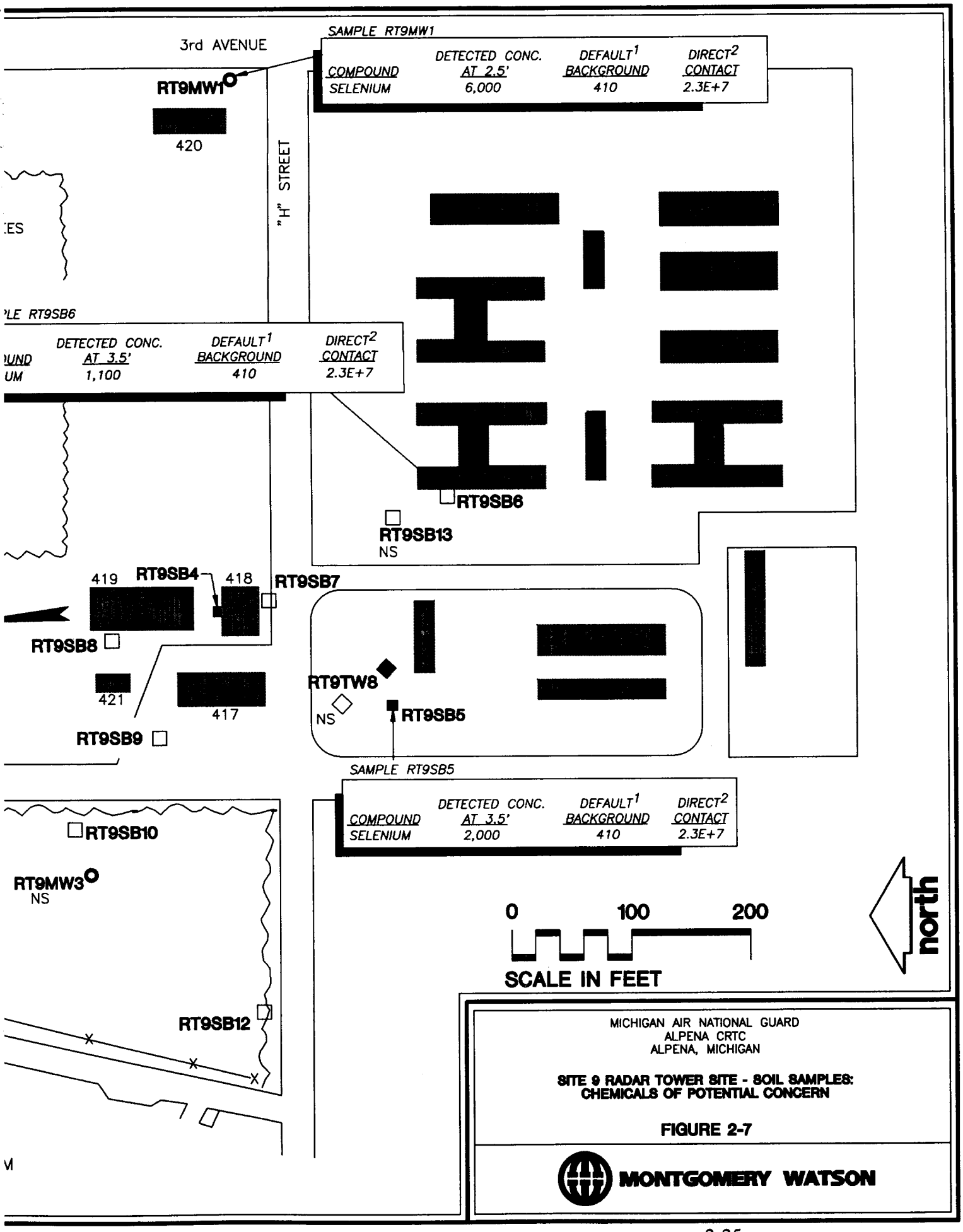
SITE 8 - FORMER SITE HANGER 9 SOIL SAMPLES: CHEMICALS OF POTENTIAL CONCERN

FIGURE 2-6

MONTGOMERY WATSON


GRASS
410
RT9MW2
NS
(GRAVEL ROAD)
TREES
SAMPLE RT9SB6
COMPOUND
SELENIUM
DETECTED
AT 3.
1,100
RT9SB1
RT9SB2
RT9SB8
RT9SB3
RT9MW4
NS
RT9MW5
NS
RT9TW7
RT9MW6
NS
2nd AVENUE
RT9MW3
NS
RT9SB11
LEGEND
410
BUILDING WITH BUILDING NUMBER
TREELINE
FENCE
SI MONITORING WELL
DEEPER SI WELL PAIR
SI SOIL BORING
RI MONITORING WELL
RI SOIL BORING
HYDROPUNCH BORING
NOTES
1. DEFAULT BACKGROUND CONCENTRATIONS FROM MDNR OPERATIONAL MEMORANDUM #15, SEPTEMBER 1993. ALL CONCENTRATIONS IN PPB.
2. DIRECT CONTACT VALUES FROM GENERIC INDUSTRIAL OR COMMERCIAL CLEANUP CRITERIA AND OTHER REQUIREMENTS, MDNR OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN PPB.



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SITE 9 RADAR TOWER SITE - SOIL SAMPLES: CHEMICALS OF POTENTIAL CONCERN

FIGURE 2-7

MONTGOMERY WATSON

- In-situ Groundwater Treatment - In-situ groundwater treatment options remediate contaminated groundwater without extraction.

- Aboveground Groundwater Treatment - Under this treatment option, groundwater is extracted and treated aboveground. Treated groundwater is either reinjected, discharged to a publicly owned treatment works (POTW), or disposed in another suitable location.

Several criteria were evaluated in determining which sites may require remedial actions for groundwater. The detected constituents in the groundwater are compared to chemical specific ARARs identified in Section 2.2.2.2. Groundwater impacts are compared with Industrial Drinking Water Values, as defined in Op Memo #14, and where applicable, to GSI values presented in Op Memo #14.

In addition, the results of the BRA for the sites were also reviewed as a criterion. There were, however, no risks identified in the BRA for groundwater pathways. Therefore, no remedial actions are required for groundwater based on the BRA. Remedial alternatives are presented for sites which do not meet the regulatory limits for groundwater contamination.

The following subsections discuss in detail the evaluation of the groundwater contamination at the Alpena CRTC sites. The discussion includes figures for each site showing the location and concentration of the chemicals of potential concern, and the estimated contaminated areas. Table 2-2 provides a summary of all chemicals of potential concern for the groundwater at all of the Alpena CRTC sites.

Table 2-2
Summary of Chemicals of Potential Concern for Groundwater
(constituents in excess of regulatory limits)
Alpena Combat Readiness Training Center
Alpena, Michigan

	Groundwater Sample Location	Detected Constituents	Rounds of Sampling				MCL[1] ppb	Industrial Drinking Water Value[2] ppb
			1987	1988	1991	1993		
Site 1	S1MW1	Benzene	NS	NS	NS	13	5	5
	S1MW6	Benzene	NS	NS	NS	10	5	5
		Antimony	NS	NS	NS	39.2	5	6
	S1MW11	Antimony	NS	NS	NS	39.2	5	6
Site 3	CG3MW3	Manganese	ND	550	ND	ND	50	500
Site 5	SF5MW1	Benzene	200	150	20	52	5	5
		1,2-Dichloroethane	5	ND	ND	ND	5	5
	SF5MW3	Pentachlorophenol	ND	ND	1.0	ND	[3]	1
	SF5MW4	Benzene	38	ND	ND	ND	5	5
	SF5MW5	Benzene	ND	170	ND	ND	5	5
	SF5MW8	Benzene	NS	NS	NS	41	5	5
Site 6/7	LF6MW3	Benzene	7.4	ND	ND	ND	5	5
		Carbon Tetrachloride	ND	ND	17	ND	5	5
		Trichloroethylene	12	12	12	ND	5	5

Table 2-2 (continued)
Summary of Chemicals of Potential Concern for Groundwater
(constituents in excess of regulatory limits)
Alpena Combat Readiness Training Center
Alpena, Michigan

	Groundwater Sample Location	Detected Constituents	Rounds of Sampling				MCL[1] ppb	Industrial Drinking Water Value[2] ppb
			1987	1988	1991	1993		
Site 8	None constituents detected in Site 8 groundwater in excess of regulatory limits							
Site 9	RT9MW1	Trichloroethylene	5.8	ND	ND	ND	[3]	5
	RT9MW4	Tetrachloroethylene	12	ND	8.4	ND	[3]	5
	RT9MW6	2-Methylnapthalene	NS	NS	NS	47	[4]	[4]
		1,2-Dimethylbenzene	NS	NS	NS	860	280	280
		1,3-Dimethylbenzene	NS	NS	NS	800	280	280
		1,4-Dimethylbenzene	NS	NS	NS	510	280	280
		Lead	NS	NS	NS	15.9	15	4

Table 2-2 (continued)
Summary of Chemicals of Potential Concern for Groundwater
(constituents in excess of regulatory limits)
Alpena Combat Readiness Training Center
Alpena, Michigan

Abbreviations:
NS Monitoring well not installed at time of sampling. No samples for this well during this round.
ND Constituent not detected in excess of regulatory limits during this sampling round.

Notes:
1) Federal Maximum Contaminant Levels (MCLs) per USEPA Office of Water Drinking Regulations and Health Advisors, under Safe Drinking Water Act (40 CFR Part 141).
2) Industrial Drinking Water Value from Generic Industrial or Commercial Cleanup Criteria and Other Requirements from Operational Memorandum #14, June 1995.
3) MCL not available for this constituent.
4) No cleanup values listed in the MDEQ guidelines for this constituent. There is currently inadequate data to develop guideline criteria.

2.4.2.1 Site 1. Based on the information presented in the RI Report, antimony was detected above Industrial Drinking Water Values at two Site 1 locations (S1MW6 and S1MW11). Antimony was only observed in groundwater perched above the intermediate subsurface clay layer. The analytical sampling data obtained from S1MW14 indicate that the antimony has not migrated vertically through the clay layer into the lower aquifer. The horizontal extent of antimony has not been fully determined. The detected levels of antimony at Site 1 are below GSI values for antimony, indicating that if groundwater is flowing into the river, it will not impact the river environment.

The RI Report indicated that benzene was detected above Industrial Drinking Water Values at two locations at Site 1 (S1MW1 and S1MW6). Analytical data from the RI Report indicate that the benzene is perched on top of the intermediate subsurface clay layer and that no migration has occurred through the clay into the lower aquifer. Based on the information presented in the RI Report, the benzene is contained on-site, as no benzene was detected at levels in excess of the Industrial Drinking Water Values in downgradient wells S1MW11 or S1MW12.

The location of groundwater constituents detected in excess of the Industrial Drinking Water Values along with a comparison to ARARs, are shown in Figure 2-8. The estimated extent of groundwater contamination is shown in Figure 2-9.

Benzene and antimony will be evaluated in the remedial action alternatives presented in this FS for Site 1.

2.4.2.2 Site 3. Based on the information presented in the RI Report, manganese was detected in the groundwater at one well (CG3MW3) during the field investigation in 1991 at levels exceeding the Industrial Drinking Water Values. No constituents were detected above Industrial Drinking Water Values in any wells, including CG3MW3, during the most recent (1993) sampling round.

There are no groundwater constituents at Site 3 that will be considered for remedial alternatives involving active treatment in this FS.

2.4.2.3 Site 5. Based on information presented in the RI Report, benzene was detected during sampling events in 1987, 1988, 1991, and 1993 at up to four locations at Site 5 (SF5MW1, SF5MW4, SF5MW5, and SF5MW8). During the most recent (1993) sampling round, benzene was only detected at levels exceeding Industrial Drinking Water Values in wells SF5MW1 and SF5MW8. No other constituents were detected above Industrial Drinking Water Values during the 1993 sampling. There were no wells sampled northeast or east (downgradient) of SF5MW1 and SF5MW8 to determine the extent of the benzene in the groundwater. Groundwater results from 1987 to 1993 for monitoring well SF5MW1 show a general decline through time in the benzene concentrations. The locations of groundwater constituents detected in excess of the Industrial Drinking Water along with a comparison to ARARs, are shown in Figure 2-10. Figure 2-11 shows the estimated extent of the benzene in the groundwater.

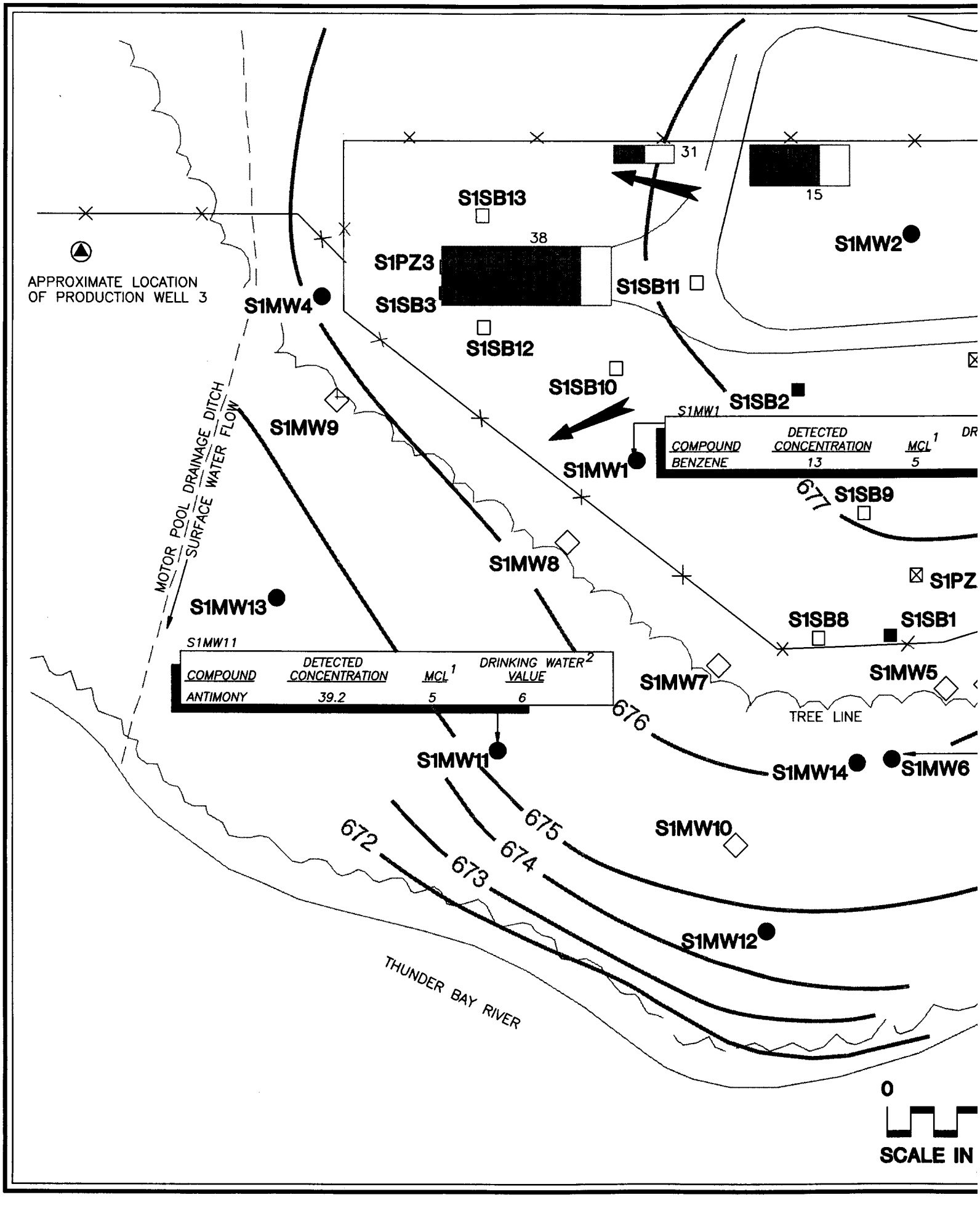
Benzene will be evaluated in the remedial action alternatives presented in this FS for Site 5.

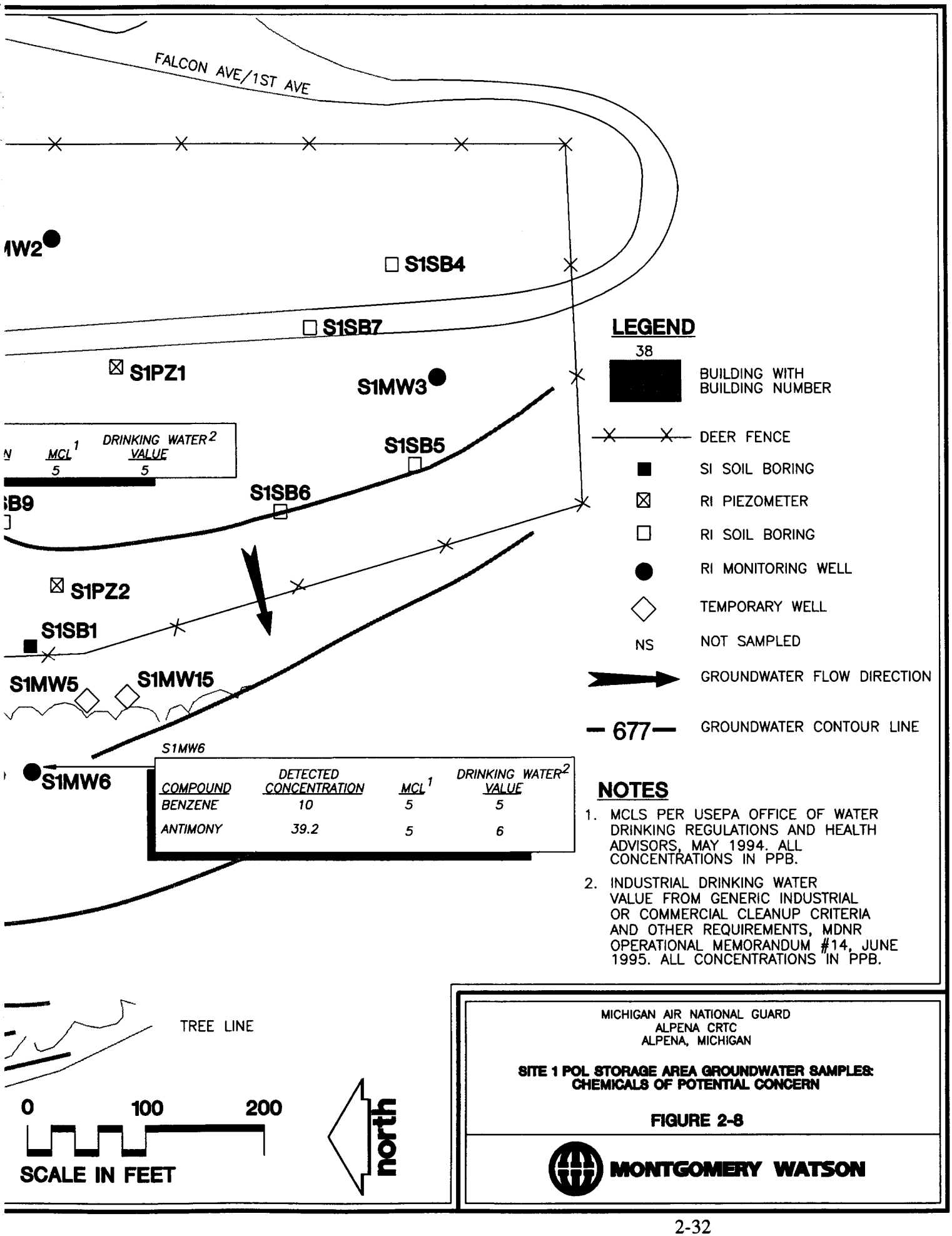
2.4.2.4 Sites 6 and 7. Based on the information presented in the RI Report, organic constituents were detected at one well (LF6MW3) during field sampling events in 1987, 1988, and 1991 at levels above the Industrial Drinking Water Values. No organic constituents were detected above Industrial Drinking Water Values in any wells, including LF6MW3, during the most recent sampling round (1993). No inorganic constituents were detected at concentrations exceeding the Industrial Drinking Water Values during any of the sampling rounds.

There are no groundwater constituents at Sites 6 and 7 that will be considered for remedial alternatives involving active treatment in this FS.

2.4.2.5 Site 8. Based on the information presented in the RI Report, no constituents were detected at Site 8 during groundwater sampling events in 1987, 1988, 1991, and 1993 at levels exceeding Industrial Drinking Water Values.

There are no groundwater constituents at Site 8 that will be considered for remedial alternatives involving active treatment in this FS.


APPROXIMATE LOCATION OF PRODUCTION WELL 3
S1MW4
S1SB13
S1PZ3
S1SB3
S1SB12
S1SB11
S1MW2
S1SB10
S1SB2
S1MW9
S1MW1
S1MW8
S1SB9
S1PZ
S1MW13
S1SB8
S1SB1
S1MW7
S1MW5
S1MW11
S1MW14
S1MW6
S1MW10
S1MW12
MOTOR POOL DRAINAGE DITCH
SURFACE WATER FLOW
TREE LINE
THUNDER BAY RIVER
31
15
38
677
676
675
674
673
672
S1MW1
COMPOUND
DETECTED CONCENTRATION
MCL 1
BENZENE
13
5
S1MW11
COMPOUND
DETECTED CONCENTRATION
MCL 1
DRINKING WATER 2 VALUE
ANTIMONY
39.2
5
6
0
SCALE IN



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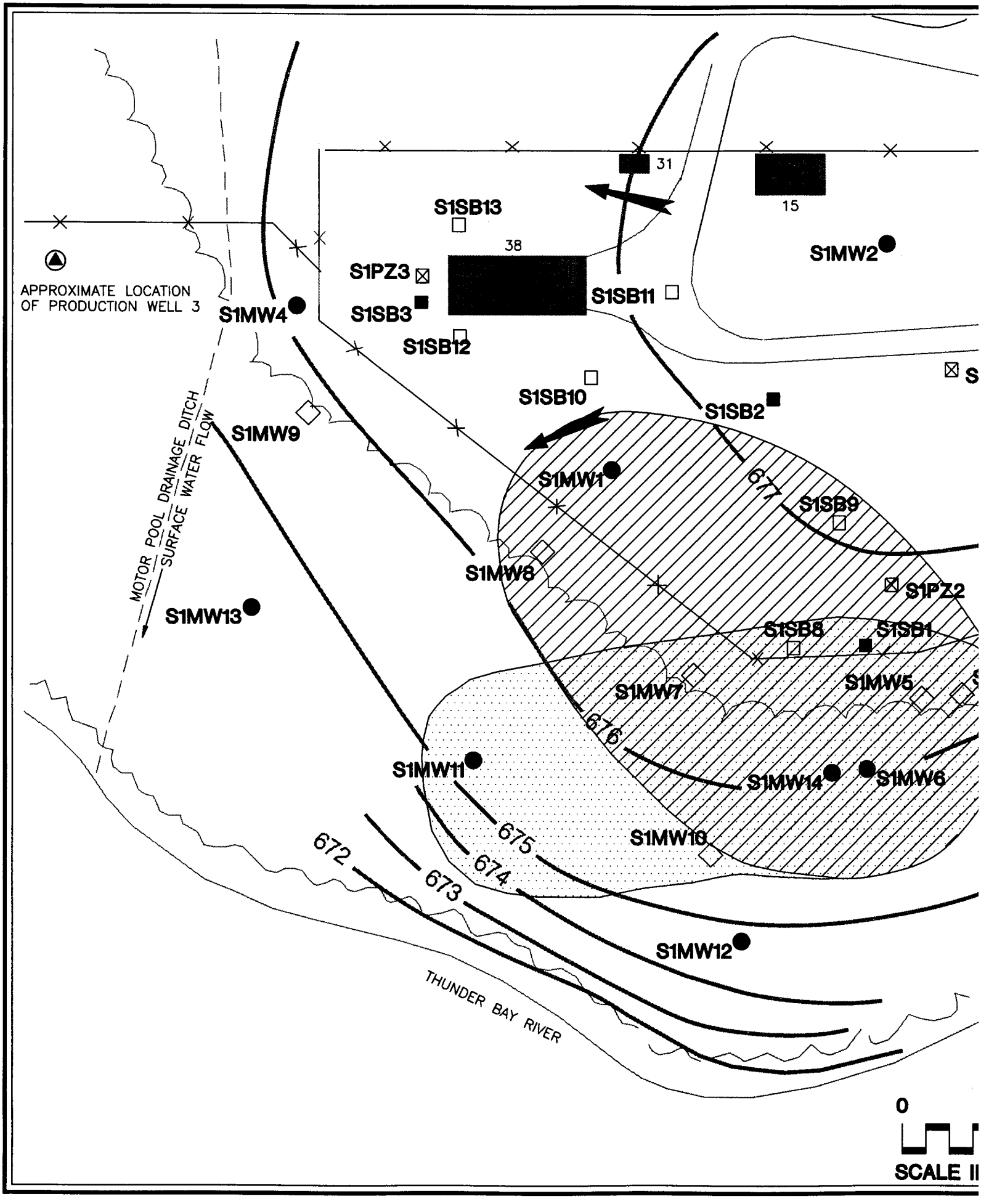
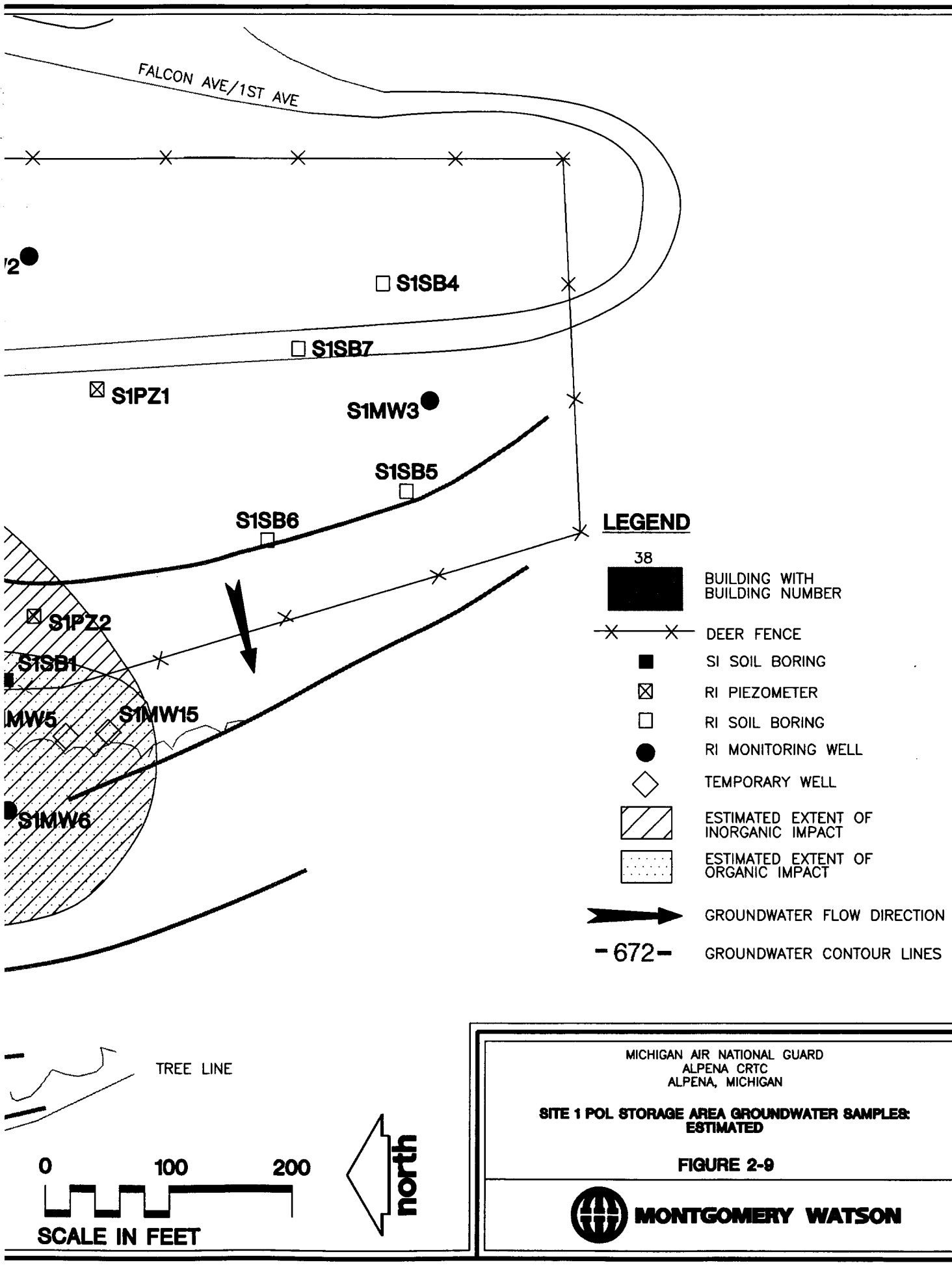
SITE 1 POL STORAGE AREA GROUNDWATER SAMPLES: CHEMICALS OF POTENTIAL CONCERN

FIGURE 2-8

MONTGOMERY WATSON


APPROXIMATE LOCATION OF PRODUCTION WELL 3
MOTOR POOL DRAINAGE DITCH
SURFACE WATER FLOW
S1MW4
S1MW9
S1MW13
S1SB13
S1PZ3
S1SB3
S1SB12
38
31
15
S1MW2
S1SB11
S1SB10
S1SB2
S1MW1
S1MW8
S1SB9
S1PZ2
S1SB8
S1SB1
S1MW7
S1MW5
S1MW11
S1MW14
S1MW6
S1MW10
S1MW12
611
616
675
674
673
672
THUNDER BAY RIVER
0
SCALE



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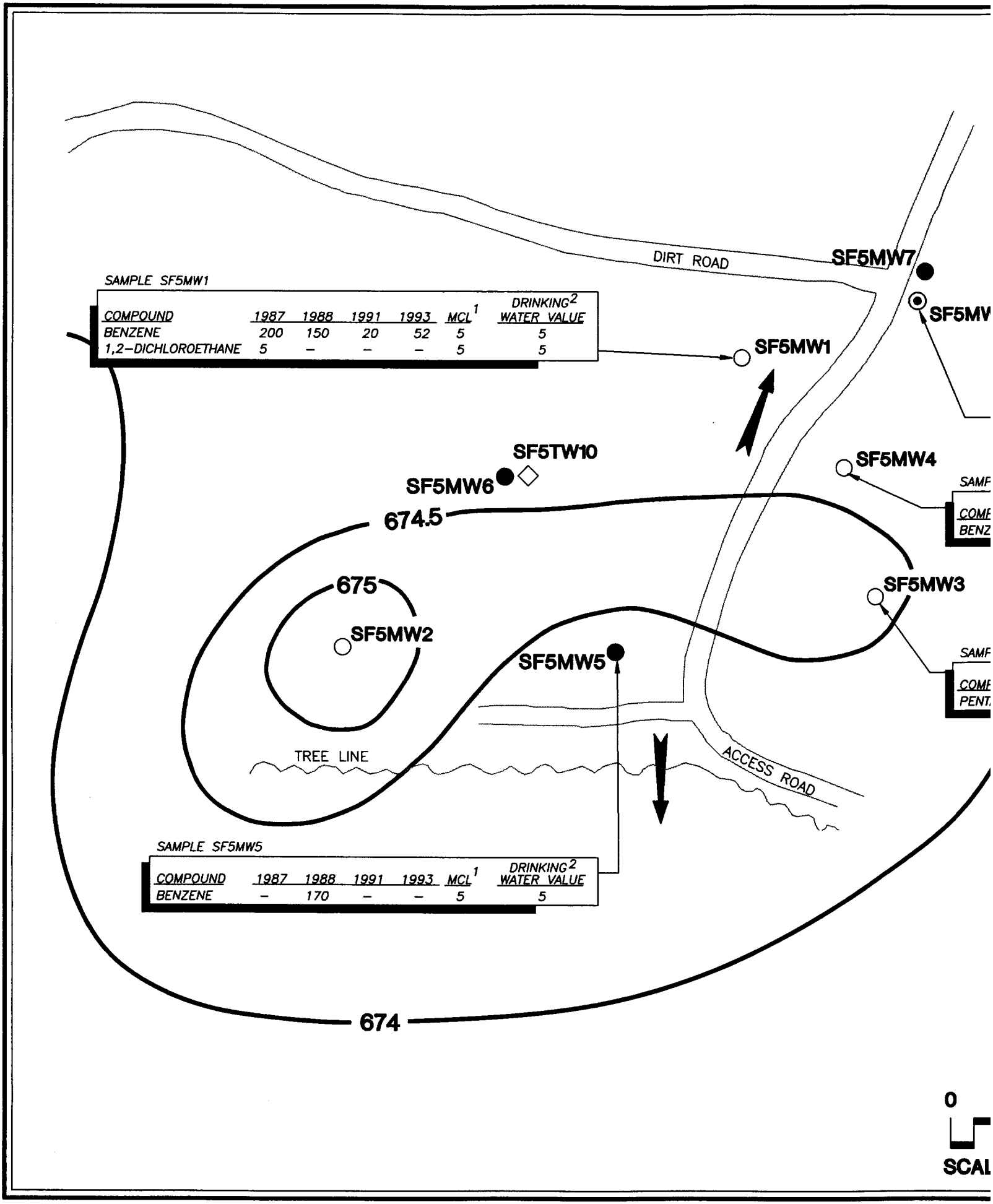
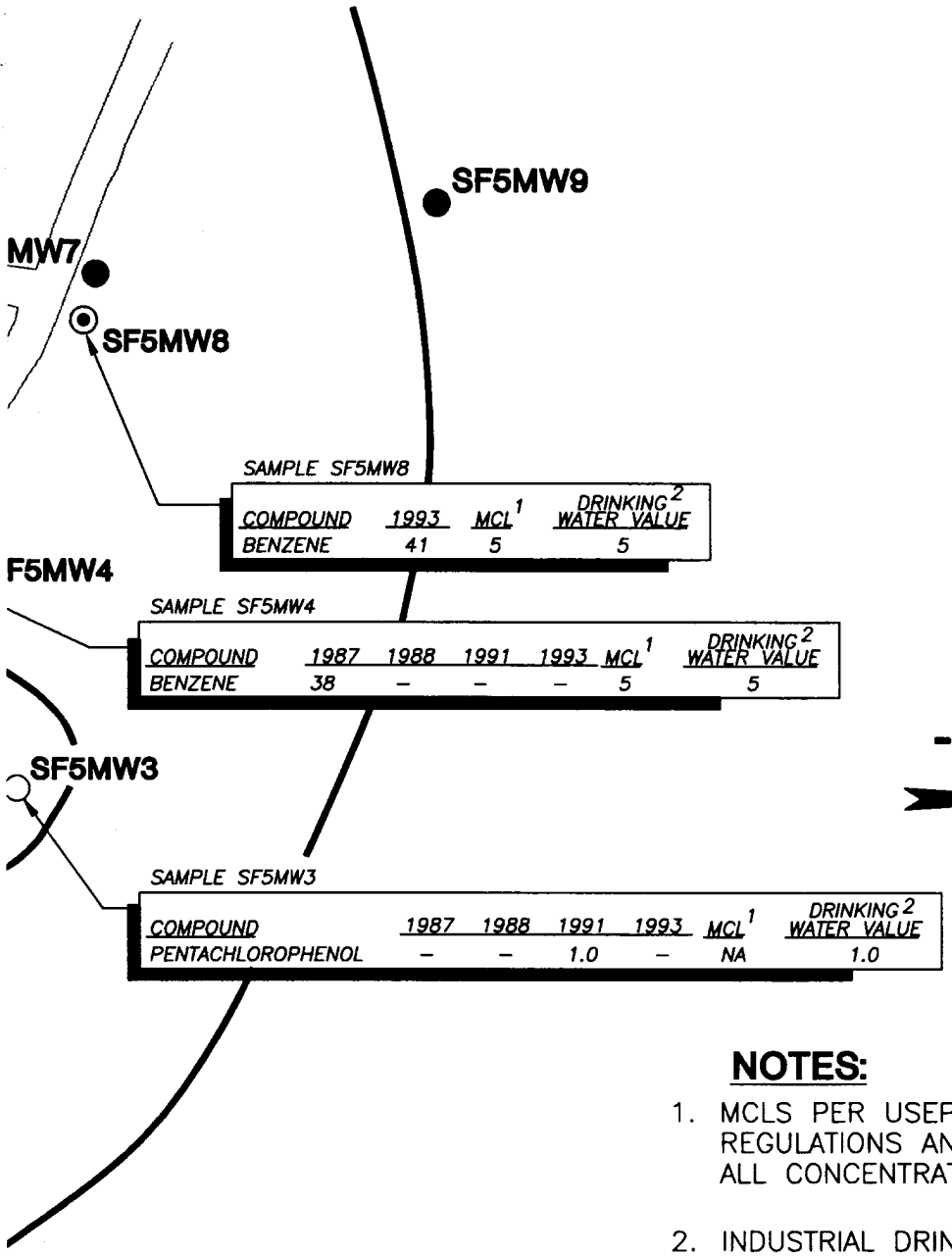
SITE 1 POL STORAGE AREA GROUNDWATER SAMPLES: ESTIMATED

FIGURE 2-9

MONTGOMERY WATSON


DIRT ROAD
SF5MW7
SF5MW
SAMPLE SF5MW1
COMPOUND | 1987 | 1988 | 1991 | 1993 | MCL[1] | DRINKING[2] WATER VALUE
BENZENE | 200 | 150 | 20 | 52 | 5 | 5
1,2-DICHLOROETHANE | 5 | – | – | – | 5 | 5
SF5MW1
SF5TW10
SF5MW6
SF5MW4
SAMP
COMP
BENZ
674.5
675
SF5MW3
SF5MW2
SF5MW5
SAMP
COMP
PENT
TREE LINE
ACCESS ROAD
SAMPLE SF5MW5
COMPOUND | 1987 | 1988 | 1991 | 1993 | MCL[1] | DRINKING[2] WATER VALUE
BENZENE | – | 170 | – | – | 5 | 5
674
0
SCAL



LEGEND

- ○ SI MONITORING WELL
- ■ SI SOIL BORING
- □ RI SOIL BORING
- ◇ TEMPORARY WELL
- ● RI MONITORING WELL
- ⦿ DEEPER RI WELL PAIR
- – NO COMPOUND DETECTED GREATER THAN CLEANUP CRITERIA
- NA NOT AVAILABLE
- -675- GROUNDWATER ELEVATION CONTOUR
- ➔ GROUNDWATER FLOW DIRECTION

NOTES:

1. MCLS PER USEPA OFFICE OF WATER DRINKING REGULATIONS AND HEALTH ADVISORS, MAY 1994. ALL CONCENTRATIONS IN PPB.

2. INDUSTRIAL DRINKING WATER VALUE FROM GENERIC INDUSTRIAL OR COMMERCIAL CLEANUP CRITERIA AND OTHER REQUIREMENTS, MDNR OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN PPB.

north

0 100 200

SCALE IN FEET

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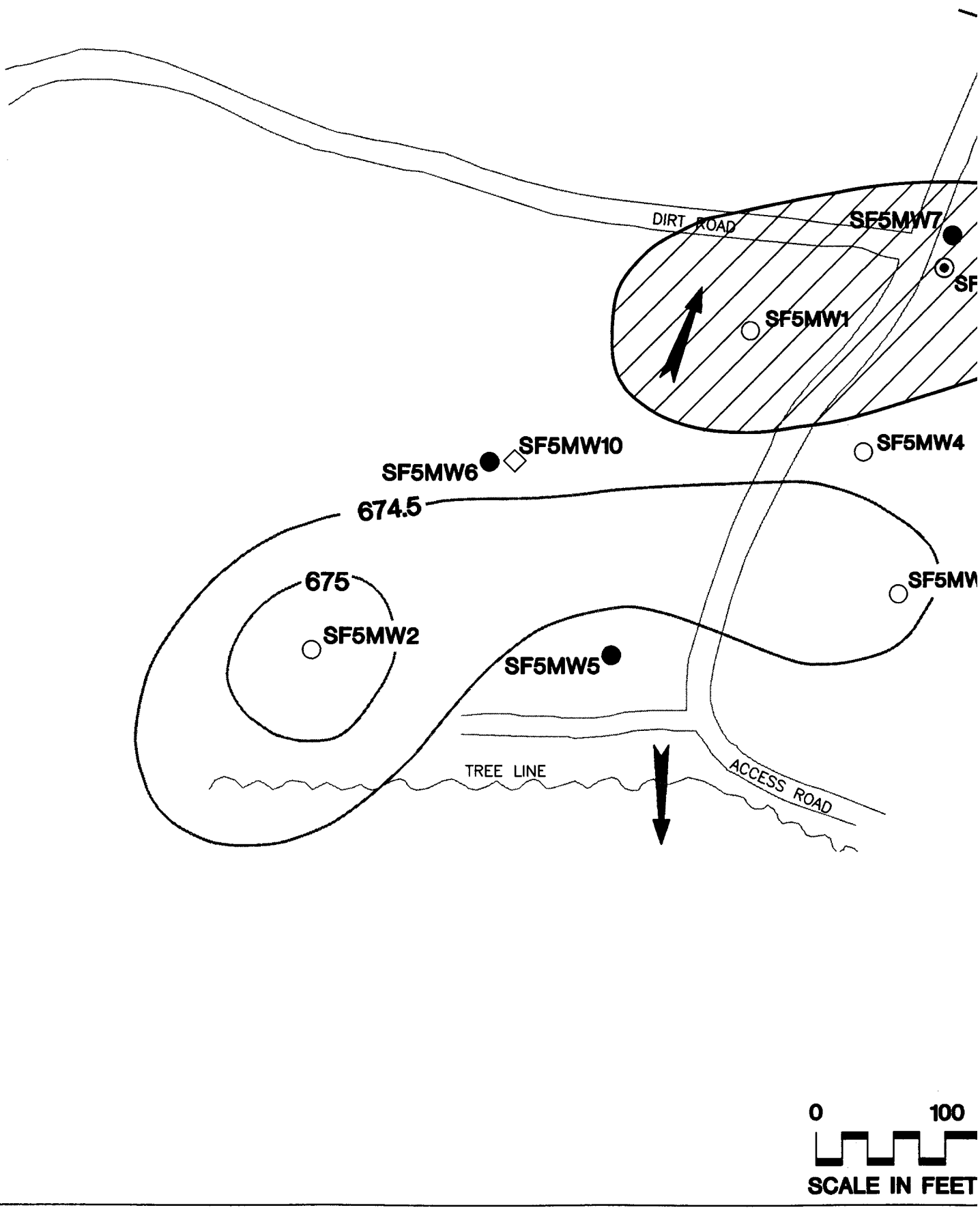
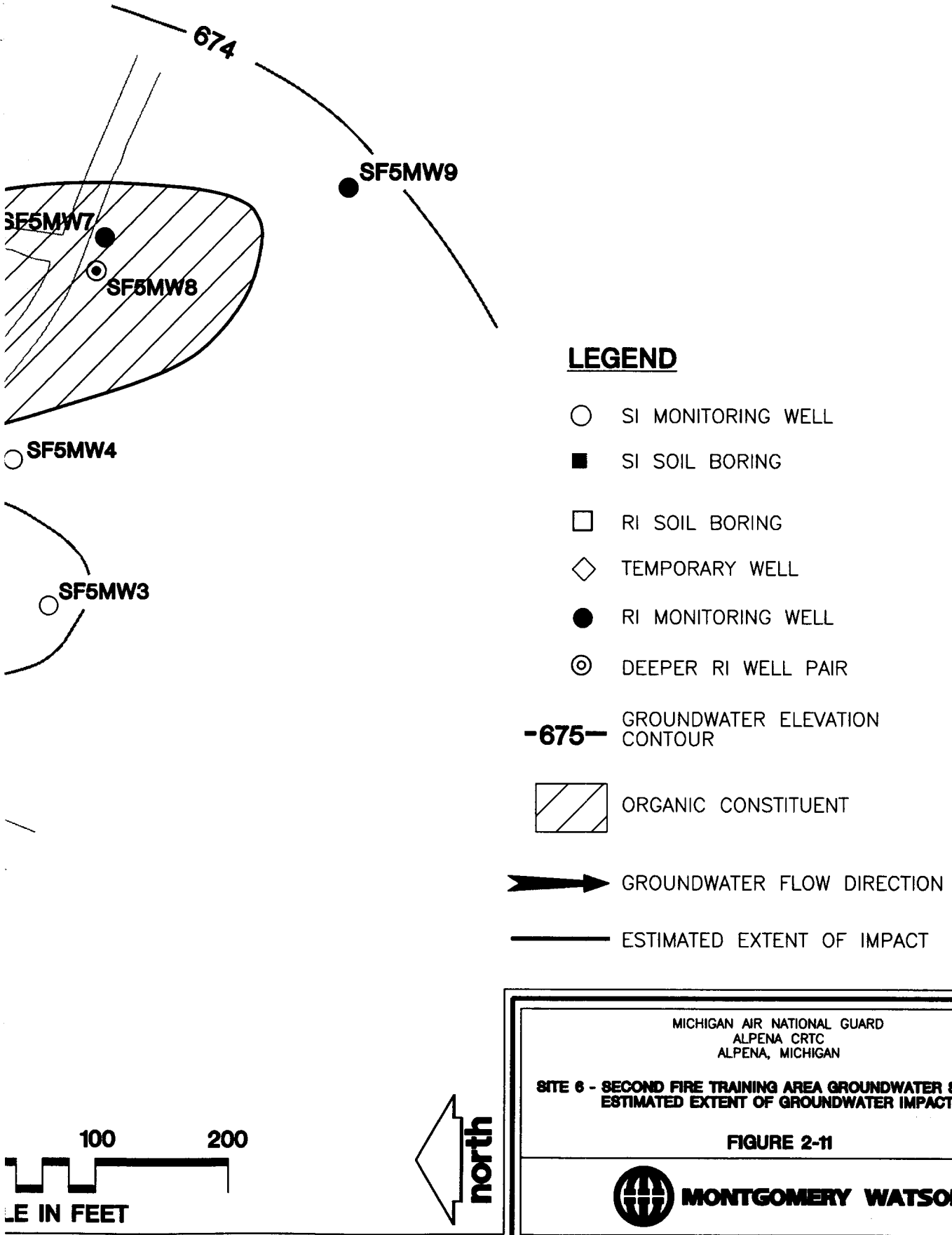
SITE 5 - SECOND FIRE TRAINING AREA: GROUNDWATER CHEMICALS OF POTENTIAL CONCERN

FIGURE 2-10

MONTGOMERY WATSON


DIRT ROAD
SF5MW7
SF
SF5MW1
SF5MW10
SF5MW6
SF5MW4
674.5
675
SF5MW
SF5MW2
SF5MW5
TREE LINE
ACCESS ROAD
0
100
SCALE IN FEET



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SITE 6 - SECOND FIRE TRAINING AREA GROUNDWATER SAMPLES: ESTIMATED EXTENT OF GROUNDWATER IMPACT

FIGURE 2-11

MONTGOMERY WATSON

2.4.2.6 Site 9. Based on the information presented in the RI Report, lead was detected during the 1993 round of sampling at concentrations exceeding the Industrial Drinking Water Value in one well at Site 9 (RT9MW6). The sampling conducted downgradient of RT9MW6 showed no lead in concentrations above the Industrial Drinking Water Values for groundwater.

Organic constituents were detected during field sampling from 1987 to 1993 in up to three wells (RT9MW1, RT9MW4 and RT9MW6) at Site 9 at levels exceeding the Industrial Drinking Water Values. RT9MW6 was the only well with detected values over the Industrial Drinking Water Values during the most recent (1993) sampling. The direction of the groundwater flow is to the northwest. RT9MW4 and RT9MW5 are both north of RT9MW6 and organic constituents were not detected above Industrial Drinking Water Values in either RT9MW4 or RT9MW5 during the 1993 sampling. However, organic constituents had been detected in RT9MW4 above Industrial Drinking Water Values prior to 1993.

The groundwater constituents detected in excess of the Industrial Drinking Water Values and the location of the detections, along with a comparison to ARARs are shown in Figure 2-12. Figure 2-13 shows the estimated extent of the groundwater contamination.

Lead and the organic constituents detected in the groundwater at this site (see Figure 2-12) will be considered in the remedial actions alternatives presented in this FS for Site 9.

2.5 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

This section discusses the identification and screening of technologies for the Alpena CRTC. Table 2-3 presents a list of candidate technologies identified for each GRA in Section 2.4. The technologies in Table 2-3 are considered applicable for treatment of organic constituents in soils and inorganic and organic constituents in groundwater. Based on information presented in the RI Report for the Alpena CRTC sites, there are organic constituents which may require remediation in soils, and inorganic and organic constituents which may require remediation in groundwater. The technology table was compiled based on professional experience, published sources, and

other available documentation. The candidate technologies included under each GRA do not preclude any other technology or response action from future consideration.

In this section, each technology is screened based on effectiveness, implementability, and relative cost. A summary of the general screening of technologies for soil is included in Table 2-4 and the screening of technologies for groundwater is in Table 2-5. The tables include columns summarizing the treatment effectiveness, the implementability, the relative cost, the result of the screening, and a brief summary of comments on the screening process.

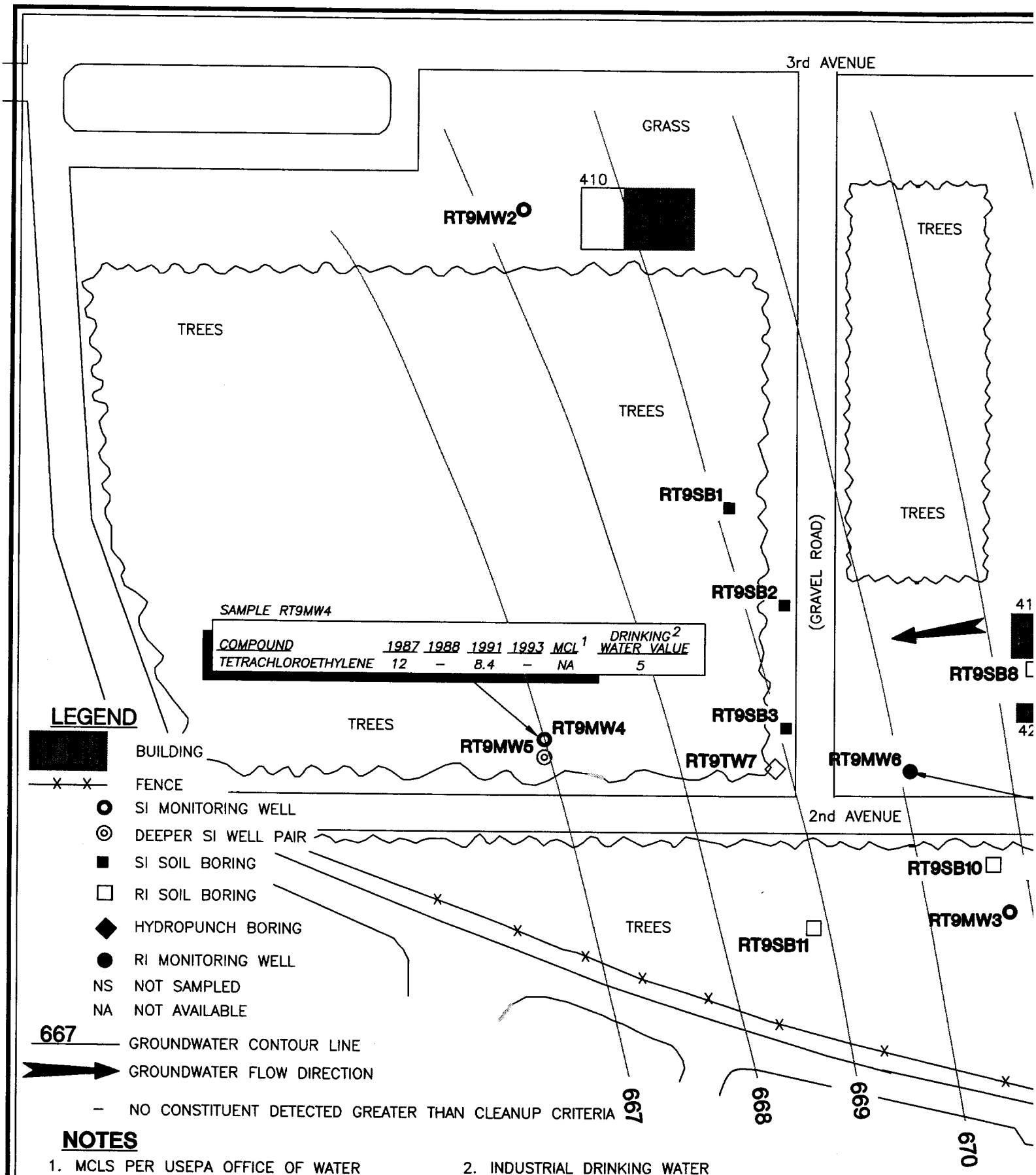
The following sections provide a discussion of the screening of the technologies identified in Table 2-3, including a presentation of technologies to be used in the formation of the remedial alternatives in Section 3.0.

2.5.1 No Action

Under the no action general response action, the current state of groundwater and soil at the site would not be altered. The no action general response action is carried through as a remedial alternative to provide a baseline for comparison of other technologies and process options.

2.5.2 Limited Action

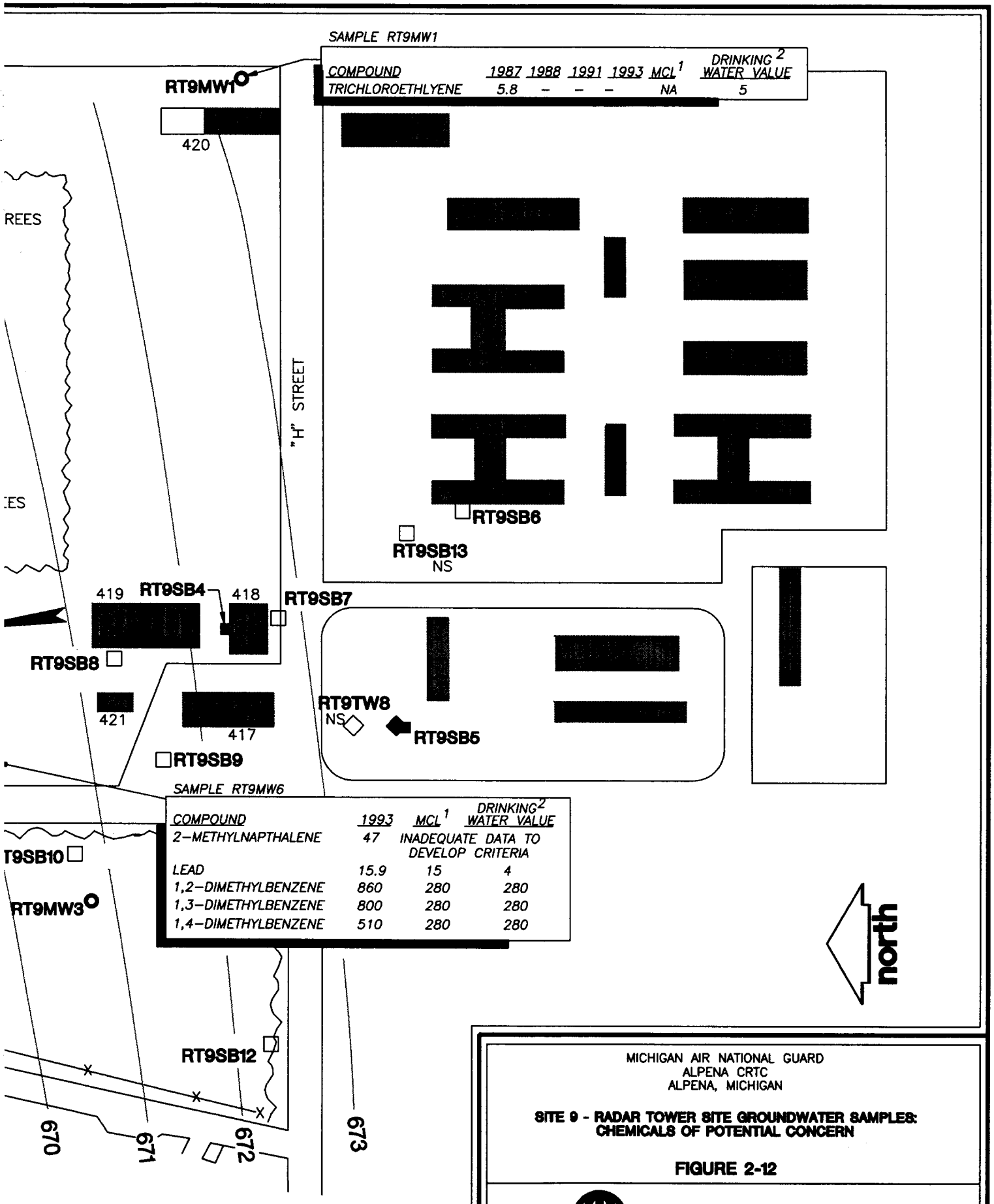
The limited action general response action does not directly effect the source of contamination, but serves to prevent contact with and monitor the contamination source until cleanup levels are met by natural attenuation and/or treatment. Limited actions include institutional controls, monitoring, and natural attenuation.



NOTES

1. MCLS PER USEPA OFFICE OF WATER DRINKING REGULATIONS AND HEALTH ADVISORS, MAY 1994. ALL CONCENTRATIONS IN PPB.

2. INDUSTRIAL DRINKING WATER VALUE FROM GENERIC INDUSTRIAL OR COMMERCIAL CLEANUP CRITERIA AND OTHER REQUIREMENTS, MDNR OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN PPB.



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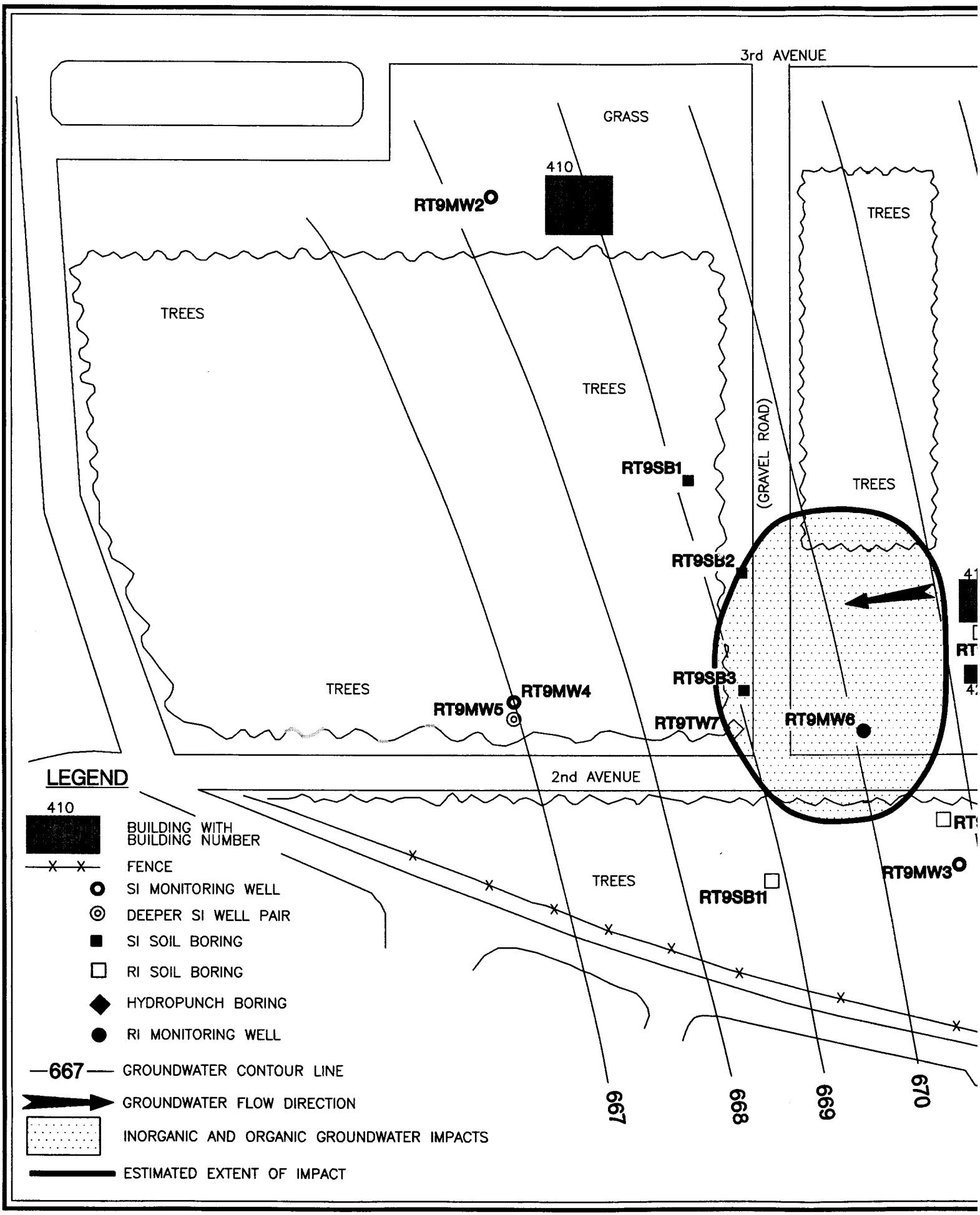
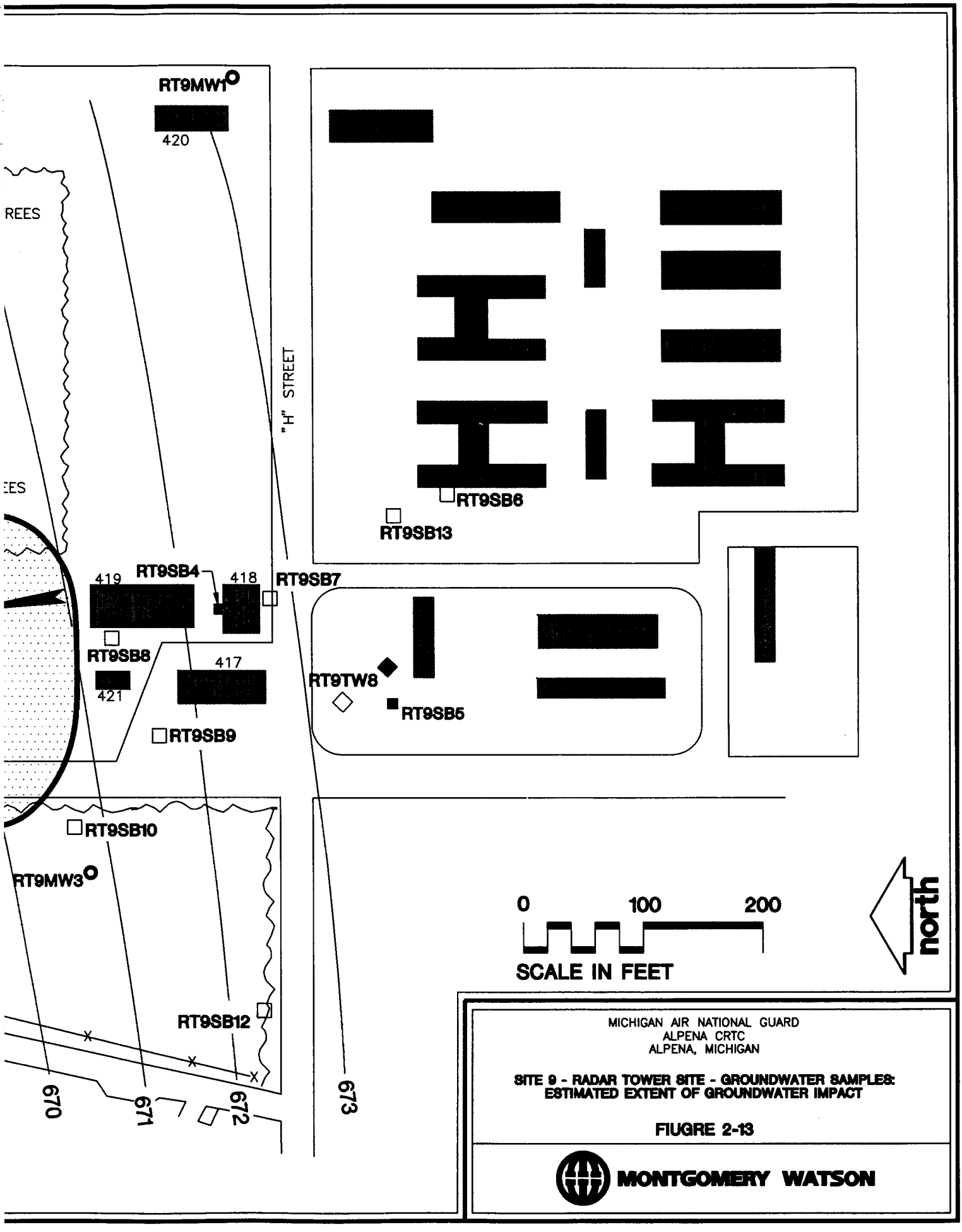
SITE 9 - RADAR TOWER SITE GROUNDWATER SAMPLES: CHEMICALS OF POTENTIAL CONCERN

FIGURE 2-12

MONTGOMERY WATSON


3rd AVENUE
GRASS
410
RT9MW2
TREES
TREES
TREES
(GRAVEL ROAD)
TREES
RT9SB1
RT9SB2
RT9SB3
RT9MW4
RT9MW5
RT9TW7
RT9MW6
2nd AVENUE
TREES
RT9SB11
RT9MW3
667
668
669
670
LEGEND
410
BUILDING WITH BUILDING NUMBER
FENCE
SI MONITORING WELL
DEEPER SI WELL PAIR
SI SOIL BORING
RI SOIL BORING
HYDROPUNCH BORING
RI MONITORING WELL
667 GROUNDWATER CONTOUR LINE
GROUNDWATER FLOW DIRECTION
INORGANIC AND ORGANIC GROUNDWATER IMPACTS
ESTIMATED EXTENT OF IMPACT



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SITE 9 - RADAR TOWER SITE - GROUNDWATER SAMPLES: ESTIMATED EXTENT OF GROUNDWATER IMPACT

FIUGRE 2-13

MONTGOMERY WATSON

TABLE 2-3
Remedial Action Objectives, General Response Actions, Technology Types, and Process Options for the Development and Screening of Technologies
Alpena Combat Readiness Training Center
Alpena, Michigan

Environmental Media	Contaminant Type	Remedial Action Objectives	General Response Action	Remedial Technology Types	Process Options
Soils	Organic	<u>For Human Health:</u>	No Action:	No Action Options:	
			No Action	No Action	NA
		Achieve levels of impacts in soils that are consistent with cleanup criteria requirements of PA 451, Part 201.	Limited Action:	Limited Action Options:	
			Institutional Controls	Institutional Controls	Fencing, Deed Restriction, Zoning
				Natural Attenuation	Monitoring
			Containment Actions:	Containment Technologies:	
		Minimize impacts to groundwater caused by impacted soils.	Containment	Capping	Single Layer, Multi Layer
				Horizontal barriers	Grouting
				Vertical barriers	Slurry Walls, Grout Curtains, Sheet Piling
		Prevent human health exposure to impacted soil that could be harmful to health and welfare.	Excavation/Treatment Actions:	Removal Technologies:	
			Excavation/treatment/disposal	Excavation	Solids Excavation
				Treatment Technologies:	
				Physical Treatment	Enhanced Volatilization, Soil Washing
		<u>For Environmental Protection:</u>		Chemical Treatment	Stabilization/Solidification
					Adsorption, Enhanced Volatilization
		Achieve levels of impacts in soils that are consistent with cleanup criteria requirements of PA 451, Part 201.		Thermal Treatment	Low Temperature Thermal Desorption, Incineration
			In-situ treatment	In-Situ Treatment Technologies:	
				Chemical Treatment	Soil Flushing, Stabilization/Solidification
		Minimize impacts to groundwater caused by impacted soils		Thermal Treatment	Vitrification
				Biological Treatment	Bio-Venting

TABLE 2-3 (Continued)
Remedial Action Objectives, General Response Actions, Technology Types, and Process Options for the Development and Screening of Technologies
Alpena Combat Readiness Training Center
Alpena, Michigan

Environmental Media	Contaminant Type	Remedial Action Objectives	General Response Action	Remedial Technology Types	Process Options
Groundwater	Inorganic	For Human Health:	No Action:	No Action Options:	
				No Action	NA
		Achieve levels of impacts in groundwater consistent with cleanup criteria requirements of Federal MCLs, and PA 451, Part 201.	Limited Action:	Limited Action Options:	
			Institutional Controls	Institutional Controls	Deed Restrictions, Alternate Water Supply
				Natural Attenuation	Monitoring
			Containment Actions:	Containment Technologies:	
				Horizontal Barriers	Grout Injection
		Prevent human health exposure to impacted groundwater that could be damaging to human health and welfare. Commission Act of 1929		Vertical Barriers	Slurry Wall, Sheet Piling
			Collection/ Treatment Options:	Extraction Technologies:	
			Collection/treatment discharge	Groundwater collection/pumping	Wells, Subsurface Drains
					Interceptor Trenches
		For Environmental Protection:		Treatment Technologies:	
				Physical Treatment	Adsorption, Reverse Osmosis
		Achieve levels of impacts in groundwater consistent with cleanup criteria requirements of Federal MCLs, and PA 451, Part 201.		Chemical Treatment	Ion Exchange, Sorptive Resins, Electro-Chemical, Alpena CRTC Wastewater Treatment Facility
			Disposal Options:	Disposal Technologies:	Alpena CRTC Wastewater Treatment Facility, Injection Wells, Thunder Bay River

TABLE 2-3 (Continued)
Remedial Action Objectives, General Response Actions, Technology Types, and Process Options for the Development and Screening of Technologies
Alpena Combat Readiness Training Center
Alpena, Michigan

Environmental Media	Contaminant Type	Remedial Action Objectives	General Response Action	Remedial Technology Types	Process Options
Groundwater	Organic	<u>For Human Health:</u>	No Action:	No Action Options:	
				No Action	NA
		Achieve levels of impacts in groundwater consistent with cleanup criteria requirements of Federal MCLs, and PA 451, Part 201.	Limited Action:	Limited Action Options:	
			Institutional Controls	Institutional Controls	Deed Restrictions, Alternate Water Supply
				Natural Attenuation	Monitoring
			Containment Actions:	Containment Technologies:	
		Prevent human health exposure to impacted groundwater that could be damaging to human health and welfare. Commission Act of 1929		Horizontal Barriers	Grout Injection
				Vertical Barriers	Slurry Wall, Sheet Piling
			Collection/ Treatment Options:	Extraction Technologies:	
			Collection/treatment discharge/	Groundwater collection/pumping	Wells, Subsurface Drains
					Interceptor Trenches
		<u>For Environmental Protection:</u>		Treatment Technologies:	
				Physical Treatment	Adsorption, Air Stripping, Reverse Osmosis
				Chemical Treatment	Advanced Oxidation
		Achieve levels of impacts in groundwater consistent with cleanup criteria requirements of Federal MCLs, and PA 451, Part 201.	In-situ groundwater treatment	In-Situ Treatment Technologies:	
				Physical Treatment	Air Sparging
				Chemical Treatment	Chemical Oxidation
				Biological Treatment	Bio-Sparging
			Disposal Options:	Disposal Technologies:	Alpena CRTC Wastewater Treatment Facility, Injection Wells, Thunder Bay River

TABLE 2-4
Summary of General Screening of Technologies for Treating Soil
Alpena Combat Readiness Training Center
Alpena, Michigan

Technology	Treatment Effectiveness	Implementability	Cost	Result of Initial Screening	Comments
NO ACTION					
No Action	NA	Easy	None	Consider	
LIMITED ACTION					
Institutional Controls	NA	Easy	Low	Consider	
Monitoring	NA	Easy	Low	Consider	
Natural Attenuation	NA	Easy	None	Consider	
CONTAINMENT					
Capping	NA	Easy	Moderate	Eliminate	Primarily used to prevent leaching.
IN-SITU SOIL TREATMENT					
Bio-Venting	Moderate	Easy	Low	Consider	Effective for non-halogenated organics.
Stabilization/Solidification	High	Easy	Moderate	Eliminate	Primarily used to prevent leaching.
Soil Flushing	Moderate	Difficult	Moderate	Eliminate	Process control difficult.
Vitrification	High	Difficult	Very High	Eliminate	High treatment costs for minor impacts.
ABOVEGROUND SOIL TREATMENT					
Stabilization/Solidification	High	Moderate	Moderate	Eliminate	Primarily used to prevent leaching.
Enhanced Volatilization	Moderate	Moderate	Low	Consider	Primarily for VOCs, less effective on SVOCs.
Incineration	High	Difficult	High	Eliminate	High O&M costs.
Soil Washing	Moderate	Moderate	Moderate	Eliminate	Produces waste stream requiring disposal.
Thermal Desorption	High	Moderate	Moderate	Eliminate	High treatment cost for minor impacts.
DISPOSAL					
Off-site Disposal	NA	Easy	Moderate	Eliminate	Future liability.
On-site Disposal	NA	Moderate	Moderate	Eliminate	No suitable landfill on site.

TABLE 2-5
Summary of General Screening of Technologies for Treating Groundwater
Alpena Combat Readiness Training Center
Alpena, Michigan

Technology	Treatment effectiveness	Implementability	Cost	Result of Initial Screening	Comments
NO ACTION					
No Action	NA	Easy	None	Consider	
INSTITUTIONAL CONTROLS					
Institutional Controls	NA	Easy	Low	Consider	
Monitoring	NA	Easy	Low	Consider	
Natural Attenuation	NA	Easy	NA	Consider	
CONTAINMENT					
Horizontal Barriers	NA	Difficult	Moderate	Eliminate	Unreliable.
Vertical Barriers	NA	Moderate	Moderate	Eliminate	No impermeable lower unit.
IN-SITU WATER TREATMENT					
Air Sparging	Moderate	Easy	Moderate	Eliminate	Moderate equipment and O&M costs.
Bio-Sparging	Moderate	Easy	Low	Consider	Only effective for non-halogenated organics.
Chemical Oxidation	Moderate	Moderate	Low	Eliminate	Poor process control.
ABOVEGROUND WATER TREATMENT					
Adsorption	Moderate	Easy	Low	Consider	Adsorbent must be treated after use.
Air Stripping	Moderate	Easy	Low	Consider	May need air permit, highly effective on VOCs.
Alpena CRTC Wastewater Treatment Facility	Low	Easy	Low	Eliminate	Not designed to treat metals or VOCs.
Electro-Chemical	High	Moderate	High	Eliminate	Expensive equipment for a minor problem.
Ion Exchange	High	Moderate	Moderate	Consider	Effective for metals in low concentrations.
Reverse Osmosis	High	Moderate	High	Eliminate	Produces a concentrated waste stream.
Advanced Oxidation	High	Moderate	High	Eliminate	Costly for non-halogenated organics.
Precipitation/Flocculation	Moderate	Moderate	Moderate	Eliminate	Better suited to high concentrations of metals.
DISPOSAL					
Alpena CRTC Wastewater Treatment Facility		Easy	Low	Eliminate	Capacity limited.
Reinjection/ Infiltration		Moderate	Low	Consider	Groundwater modeling required.
Thunder Bay River		Moderate	Low	Eliminate	Future liability and image problems.

2.5.2.1 Institutional Controls. Institutional controls can be implemented to limit human contact with the source of contamination. Institutional controls often include access restrictions, land use restrictions, and deed restrictions.

2.5.2.1.1 Access Restrictions. Access restrictions include the construction of security fences that prevent direct contact with impacted site media and the posting of signs to warn the public of potential health risks. The Alpena CRTC is surrounded by a chain link fence ranging in height from 8 to 12 ft. The facility also has posted guards at all entrances 24 hours a day. This is effective in keeping the public and animals from coming in contact with the sites containing impacts. Access restrictions, which provide some protection of human health and the environment, are currently in place.

2.5.2.1.2 Land Use Restrictions. Land use restrictions prohibit future construction of housing developments, schools, parks, etc., at the site, as well as limitations on other activities (e.g., vehicular traffic). The limitations for a site are identified based on the risk and exposure pathways present at the site, as well as the remedial actions likely to be implemented. Restrictive covenants, written into the land property deed, notify any potential purchaser of the property of past land use and that future land use must be restricted in order to ensure the isolation of the area and the integrity of any existing or future waste containment system. The effectiveness of land use restrictions depend on state and local laws, continued enforcement, and maintenance. Most restrictions are subject to changes in political jurisdiction, legal interpretation, and level of enforcement. It is anticipated that some of the Alpena CRTC sites may require the restriction of certain activities during and after remedial actions operations. For example, a newly-closed, capped site may require protection by restricting subsurface activities and excessive vehicular traffic.

2.5.2.1.3 Deed Restrictions. Deed restrictions can be used to prevent construction activities at the site and can be implemented with other technologies at the sites. In some cases deed restrictions can be used to limit exposure to impacted media until cleanup levels are met. Deed restrictions can also be put in place to prevent use of groundwater at the site.

Institutional controls eliminate pathways between the public and the source of contamination; therefore, it is retained for the development of remedial alternatives.

2.5.2.2 Monitoring. Monitoring can be used to track the concentration of the constituents detected in the soil, and the direction and rate of movement for constituents detected in groundwater. Monitoring can be used to evaluate the effectiveness of an alternative if contamination is left in place. Incomplete removal of contamination in soils and groundwater may be involved in one or more alternatives, therefore monitoring is retained for further consideration.

2.5.2.3 Natural Attenuation. Natural attenuation is a process which reduces the concentration of a constituent by diffusion, dilution, microbial degradation, precipitation, or sorption. Natural attenuation is appropriate at sites where the impacts will safely and naturally attenuate without risk to human health or the environment.

2.5.3 Containment Actions

Containment actions seek to isolate the impacts and minimize migration through the use of engineering controls. This section includes the presentation of containment actions for soil followed by the presentation of groundwater containment actions.

2.5.3.1 Soil Containment Actions. Containment technologies for soil are those technologies that prevent vertical migration of impacts through the vadose zone. Containment actions considered for soils at the Alpena CRTC sites include capping.

Capping can substantially limit dermal contact with potential human and animal receptors. The cap also minimizes rainwater infiltration through the impacted soils. Infiltrated rainwater can leach heavy metals and carry organic constituents into the groundwater. Since the primary purpose for a cap is the reduction of infiltration of rainwater at a site and leaching is not a concern at the Alpena CRTC sites, capping will not be retained for further consideration.

2.5.3.2 Groundwater Containment Actions. Containment technologies (vertical and horizontal barriers) for groundwater are those technologies that prevent the migration of constituents. Vertical barriers are used as containment actions for groundwater. Vertical barriers limit the horizontal movement of groundwater. Without a natural low permeability unit for the vertical barriers to tie into, groundwater segregation cannot be guaranteed. Horizontal barriers are difficult to install and are not reliable. Vertical and horizontal barriers for groundwater are not retained for further consideration.

2.5.4 Treatment Actions

The treatment actions evaluated in this section include technologies for treatment of impacted soils and groundwater both aboveground and in-situ. This section presents the treatment actions for soils followed by the treatment actions for groundwater.

2.5.4.1 Soil In-situ Treatment Processes. The in-situ treatment technologies evaluated for soils include bio-venting, soil flushing, stabilization/solidification, and vitrification. Bio-venting is retained for further consideration.

2.5.4.1.1 Bio-Venting. Bio-venting is a treatment process by which enhanced destruction of biodegradable substances occurs. This is generally accomplished by adding nutrients to the soil. Nutrients can include nitrogen, phosphorous, potassium, oxygen, and carbon. Generally the nutrient limiting biological activity is oxygen. In bio-venting, a blower provides a source of air to a well point that is located in the area of concern in the unsaturated portion of the soil. The goal is to supply enough air to enhance bio-activity, but not so much as to actively carry impacts to the surface and into the atmospheric air. The area effected by one well is fairly small, and large areas may require multiple well points. The cost for this technology is low compared to other treatment technologies for soil. Bio-venting is applicable to organic non-chlorinated substances located at several of the Alpena CRTC sites. Bio-venting is an effective low cost method of treating organic constituents and is retained for further consideration.

2.5.4.1.2 Soil Flushing. Soil flushing is a process that uses water or surfactant solutions to extract contaminants from soils and sediments. Soil flushing is an in-situ method that mimics the natural infiltration process. Flushing fluids are introduced into the saturated zones of the soil via leach-fields, injection wells, or recharge trenches, and are allowed to percolate through the soil to the water table. The leachate is then extracted through the use of pumping wells, treated, and recirculated. Soils may need several flushing/washing cycles for effective contaminant removal. Soil flushing can be used for either inorganic or organic impacts. Soil flushing is particularly effective when hydraulic controls can be established. The effectiveness of in-situ soil flushing may be limited by a lack of subsurface process control. The effectiveness of soil flushing is suspect in areas where soils contain high to moderate permeability sands and gravel is inter-layered with low permeability silts and clays. Introduction of solvents to the ground for the flushing also creates the potential for soil and groundwater contamination. Soil flushing is not retained for further consideration based on the potential for creating further contamination of the groundwater through flushing and the lack of process control.

2.5.4.1.3 In-Situ Stabilization/Solidification. In-situ stabilization/solidification is achieved by a deep soil mixing technique that directly applies solidification agents to the soils to reduce the mobility of the impacts. Mobility is reduced by binding the compounds into a solidified mass with low permeability that resists leaching. Various agents have been used to enhance binding, such as cement-based, pozzolanic-based, silicate-based, or asphalt-based additives. Solidification technologies have been most widely successful when applied to inorganic wastes. When a highly alkaline solidification agent such as Portland cement is used, an added stabilization effect is gained. Stabilization occurs when the highly alkaline material used for solidification reduces the leachability of the heavy metals. Several vendors use organophilic proprietary compounds as additives to bind organic constituents to the soil matrix. Bench-scale treatability studies are essential for determining the applicability of the method and for evaluating the choice of critical parameters, such as effectiveness of solidification agents and other additives, waste-to-additive ratio, and mixing and curing conditions. Disadvantages include the unknown long-term behavior of the solidified mass and the potential limitations on the future uses of the site depending on the final properties of the solidified soil material. In addition, the presence of a variety of compounds

is expected to reduce the effectiveness of the solidification process. Furthermore, continued monitoring of the site may be required because the contamination is left on site. In-situ solidification/stabilization does not remove impacts or prevent human health risks associated with impacts. In-situ solidification is readily implemented and requires moderate capital expenditure. Since the primary reason for using solidification/stabilization is the reduction of mobility to reduce leaching and not the reduction of human health risk, solidification/stabilization will not be retained.

2.5.4.1.4 Vitrification. Vitrification involves melting the contaminated soil in place to bind the waste in a glassy solid matrix resistant to leaching. Organic constituents in the soil vaporize and are destroyed in the high heat zone directly above the electric heating elements. Costs for this process are high compared to other treatment alternatives for soil. The level of impacts at this site are not high enough to justify the use of this treatment technology. In-situ vitrification is not retained for consideration.

2.5.4.2 Soil Aboveground Treatment Processes. The aboveground soil treatment technologies screened include soil washing, thermal desorption, stabilization/solidification, enhanced volatilization, and incineration. Enhanced volatilization is retained after the screening process.

The first step in any aboveground treatment technology is the excavation of the impacted soil. Excavation is a feasible and effective means of removing the source of contamination when the impacts are limited to shallow depths. Monitoring air quality is required during excavation. When fugitive air emissions exceed air quality standards, limitations on the quantity of soil that can be excavated per day may be imposed. However, this should not be of concern at the Alpena CRTC sites, since limited amounts of volatile compounds were detected.

2.5.4.2.1 Soil Washing. Soil washing is an aqueous-based technology that generally uses mechanical processes to separate particles that contain contaminants. In this sense it is a volume reduction or pretreatment technology. It takes advantage of the fact that contaminants generally adhere to the organic carbon and fine-grained soil fraction, such as silt and clay, as opposed to the

coarse grained mineral fraction, such as sand and gravel. In addition, contaminants may be removed from the soil by dissolving them in the wash water. Surficial impacts are removed from the coarse fraction by an abrasive scouring action. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, oxidizer or chelating agent to help remove organic constituents or heavy metals. Treated soil is cleaned of residual additive compounds, and the spent wash water is treated to remove the contaminants prior to recycling back to the treatment unit. The cost of soil washing is moderate compared to other soil treatment technologies. Soil washing is cost effective when large quantities of soil are being treated. The process is very involved and tends to require a great deal of housekeeping to keep additional areas from becoming contaminated. The organic material with the absorbed metals will still need to be treated and disposed in an off-site facility or possibly recycled through a metal smelter. Off-site disposal is accompanied by liability. Due to the cost of soil washing and the liability associated with the additional waste stream, it is not retained for further consideration.

2.5.4.2.2 Stabilization/Solidification. Stabilization/solidification is the same process described in the in-situ section except that the process occurs aboveground. Soils are excavated and then processed (mixed) with the chemicals to fix the metals in the soil. Once processed, the soils can be returned to the excavation. Equipment for this treatment system is relatively small and portable and is capable of treating small or large areas. This treatment is typically used when soils contain both inorganic and organic constituents and the soil must be excavated for aboveground treatment of the organic constituents. Since there are no inorganic constituents in soils and other aboveground technologies are more appropriate for organic constituents, this alternative will not be retained.

2.5.4.2.3 Enhanced Volatilization. Enhanced volatilization consists of optimizing conditions for volatilization of the VOCs that readily volatilize from soils. Soils containing VOCs are excavated and screened to remove large, non-processable materials and debris. Soils are processed through a soil shredder, reducing the soil particle size and volatilizing the VOCs within the soil. The soils are rescreened and reprocessed as necessary until soils meet the required cleanup objectives. The shredder can be hooded and the exhaust directed to an off-gas treatment

system. The treatment system can be an adsorption system such as activated carbon or a thermal system such as catalytic oxidation followed by off-gas scrubbing. Enhanced volatilization is inexpensive relative to other treatment technologies for soil, and remediation can be accomplished in a short time frame. This technology is retained for further consideration.

2.5.4.2.4 Thermal Desorption. Thermal desorption is a process of contaminant removal which transfers contaminants from one physical state to another. The system operates by targeting an operational temperature at which the contaminants vaporize and become part of the gas stream. This removal mechanism is a physical transfer from the liquid phase to the vapor phase. The gases are removed under negative pressure and routed into a secondary treatment unit where they are further heated and oxidized. The result of this process is a transformation of organic compounds into primarily carbon dioxide and water. Halogenated hydrocarbons are converted to simple halogenated acids. Thermal desorption is a commonly used technology for the removal of VOCs from soils. However, the concentrations of VOCs and SVOCs in the soils and sediments at the Alpena CRTC sites are relatively small. There was only one detection of a SVOC at one of the sites at Alpena CRTC. Thermal desorption, while effective, is costly for the low levels of VOCs at the sites. Therefore, thermal desorption is not retained for further consideration.

2.5.4.2.5 Incineration. Incineration is a process by which combustible materials such as organic constituents are destroyed and converted to carbon dioxide and water. Any non-combustible material is discharged as ash. These systems run at temperatures between 1400° to 2500° Fahrenheit (F). Achieving these temperatures requires a great deal of energy. Wastes with a high fuel value lend themselves well to incineration. Based on the information presented in the RI Report, the sites at the Alpena CRTC do not have soils with a high fuel value. Incineration has a poor public image and is usually difficult to permit. Due to the poor public image, relative cost, and the low fuel value of the Alpena CRTC site soils, incineration is not retained for further consideration.

2.5.4.3 Groundwater In-situ Treatment Processes. The in-situ treatment technologies evaluated for groundwater include air sparging, bio-sparging, and chemical oxidation. Bio-sparging is the only technology that passed the technology screening step.

2.5.4.3.1 Bio-Sparging. Bio-sparging employs naturally occurring processes that utilize microbial metabolism to degrade organic contaminants. The goal behind enhanced bio-sparging is to provide an environment where a population of micro-organisms will grow by several orders of magnitude over their naturally occurring populations. This can speed the natural degradation of hydrocarbons from years to months. Aerobic (oxygen using) bio-sparging is very effective in metabolizing non-halogenated hydrocarbons. All of the constituents in the groundwater that may require treatment are non-halogenated hydrocarbons. The naturally occurring aerobic processes can be enhanced by the addition of nutrients including oxygen, nitrogen, potassium, phosphorus, and carbon. The most beneficial and economical nutrient that can be added the groundwater to aid aerobic bio-degradation is oxygen. Oxygen can be added by bio-sparging, infiltrating oxygen saturated water into the groundwater, and hydrogen peroxide injection. Bio-sparging and hydrogen peroxide injection are less expensive than infiltrating oxygen saturated groundwater. Hydrogen peroxide addition is difficult to control as it is an oxidizing agent and can kill the micro-organisms if the concentration is too strong. Bio-sparging involves injecting a small quantity of air through well points into the groundwater using a small blower or compressor. Just enough air is injected to saturate the surrounding groundwater but not cause active volatilization. Any hydrocarbon volatilization that does occur is usually aerobically metabolized in the vadose zone. Bio-sparging has very little effect on the inorganic constituents in the groundwater. Cost for bio-sparging are low relative to other groundwater treatment technologies, and the technology is effective for non-halogenated organic constituents. Bio-sparging is retained for further analysis.

2.5.4.3.2 Chemical Oxidation. Chemical oxidation consists of pumping oxidants such as hydrogen peroxide or ozone into the groundwater to oxidize contaminants in the groundwater. Oxidants are infiltrated into the groundwater or injected with infiltration wells. Generally, the oxidants do not need to be recovered because their breakdown products, water and oxygen, are harmless. Like soil flushing, the chemical oxidation process lacks subsurface process control.

Chemical oxidation is a relatively new process and has not been thoroughly proven. Due to the lack of data on chemical oxidation and the lack of subsurface process control, chemical oxidation is not retained for further analysis.

2.5.4.3.3 Air Sparging. Air sparging is a mass transfer process that uses air to actively volatilize VOCs in groundwater into an air phase. Air is injected directly into the ground using well points. VOCs vaporize into the air bubbles and are carried to the groundwater surface by the natural buoyancy of air. The hydrocarbon laden air is either treated by microbial activity in the vadose zone or escapes to the atmosphere. Depending on the constituent and the location of nearby buildings, a vapor extraction system may be employed to collect the sparged air. The captured air is sent to off-gas treatment equipment before being released to atmosphere. Air sparging is a proven technology that has been successful in treating VOCs in groundwater at many sites. SVOCs are only mildly effected by air sparging because SVOCs take longer to volatilize than VOCs. Air sparging has very little beneficial use in treating heavy metal impacts in groundwater. While air sparging is highly effective for VOCs, the quantity of VOCs at Alpena CRTC does not warrant the equipment purchase that air sparging will require. Due to cost of air sparging relative to the level of contamination, air sparging is not retained for further consideration.

2.5.4.4 Groundwater Aboveground Treatment Processes. The aboveground technologies for groundwater that were screened include treatment by Alpena CRTC Wastewater Treatment Facility (WTF), advanced oxidation, precipitation/flocculation, electro-chemical, ion exchange, adsorption, air stripping, and reverse osmosis. Adsorption, air stripping, and ion exchange passed the technology screening step.

The first step in an aboveground treatment technology for groundwater is to extract the groundwater to the treatment equipment. The groundwater can be extracted by either wells or by drains, such as French drains. French drains use horizontal perforated pipes to extract groundwater in the immediate vicinity of the drain. These drains work well when the water level is close to the surface and the subsurface has a low permeability. Wells can be used in either

shallow or deep applications and are appropriate for high permeability aquifers. Both French drains and wells will be evaluated in combination with the treatment technologies listed below for extraction of the groundwater.

2.5.4.4.1 Wastewater Treatment Facility. The WTF is intended for treating municipal wastewater. The WTF is likely capable of treating a small quantity of hydrocarbons, but does not have the ability to treat metals. Currently the WTF is running at approximately 50 to 60 percent of it maximum flow rate of 100,000 gallons per day (gpd). There is approximately 30 gallons per minute (gpm) available capacity at the WTF. Extraction rates likely to be used during the Alpena CRTC remediation will generally require higher capacities. Since treatment of the groundwater by the WTF is questionable and will remove valuable sewage treatment capacity, the WTF is not retained for further consideration.

2.5.4.4.2 Advanced Oxidation Processes. Advanced oxidation processes (AOPs) are defined as those that involve the generation of hydroxyl radicals in sufficient quantity to impact water treatment. Examples of AOPs include ozone/hydrogen peroxide, ozone/ultraviolet (UV) radiation, UV/hydrogen peroxide and ozone/UV/hydrogen peroxide. The advantage of AOPs is that they potentially provide more powerful oxidation and at faster rates than achieved by a single oxidant. This allows oxidation of a variety of compounds which in the past have not been treatable with conventional oxidation processes. AOPs have been shown to successfully treat benzene, toluene, ethylbenzene, and xylene (BTEX) and common chlorinated solvents. One advantage of AOPs is that the oxidation process generally produces carbon dioxide, water, and simple organic and halogenated acids. The carbon dioxide is highly soluble, therefore no off-gases are produced and the simple acids are relatively innocuous. AOPs actually destroy the organic constituents as opposed to simply removing and storing them. AOPs do not reduce metal concentrations which may be present in the groundwater. Often different combination of AOP technologies are necessary to treat the different properties of constituents. Each of the AOP technologies involves moderate capital cost which when combined can result in a very costly system. Systems that use UV radiation can have expensive operational cost in addition to the

capital cost. Due to the cost of AOPs relative to the levels of impacts at the Alpena CRTC, AOPs are not retained for further consideration.

2.5.4.4.3 Precipitation/Flocculation. Precipitation is the process by which a chemical reaction changes a soluble metal ion into a fairly insoluble compound. Typical precipitation agents include lime (calcium hydroxide), magnesium hydroxide, and various sulfides. Generally, sulfide precipitates are less soluble and more stable than the hydroxide precipitates. Hydroxide precipitates can be redissolved by acidification.

Flocculation is the process by which small particles of precipitate join together to make a larger particle. These large particles are generally easier to remove from solution than the individual precipitated particles. Flocculation can be encouraged by the addition of various ionic chemicals, such as polymers, that attract the small precipitate particles.

Precipitation/flocculation are standard processes for metal removal in the wastewater industry. However, precipitation/flocculation is a rough removal process. It removes a large quantity of contaminants, but is not able to remove low concentrations of metals in the groundwater. Since this site only has minor inorganic groundwater impacts, precipitation/flocculation is not retained for further consideration.

2.5.4.4.4 Electro-Chemical Process. The electro-chemical process can remove heavy metals from contaminated groundwater. The process uses a direct current across a consumable, carbon steel electrode to generate an insoluble iron matrix which adsorbs and coprecipitates heavy metals. The insoluble constituents are separated from the aqueous stream by clarification and dewatering. This process has been shown to be cost-effective for high concentrations of heavy meals in water. At the Alpena CRTC sites, the technology is not cost-effective for the minor amount of heavy metals present in the groundwater. On the basis of high operating costs, the electro-chemical process is not retained for further consideration.

2.5.4.4.5 Ion Exchange. Ion exchange systems can be used to remove heavy metals from water. An ion exchange system consists of a tank containing small beads of synthetic resin. The beads are treated to selectively adsorb either cations or anions, and exchange certain ions based on their relative activity compared to the resin. This process of ion exchange continues until all available exchange sites are filled, at which point the resin is exhausted and must be regenerated by suitable chemicals. Ion exchange uses a two stage process to remove most ionic material in water. Two types of synthetic resins are used: one to remove positively charged ions and another to remove negatively charged ions. Ion exchange is capable of reducing metals in water to very low levels. It is expensive to remove large quantities of metals from water with ion exchange. At the Alpena sites ion exchange represents a moderate capital expenditure with relatively low operation and maintenance (O&M) cost thereafter. Ion exchange is applicable to the Alpena CRTC sites considering the low levels of metals in the groundwater and its ability to remove metals to very low concentrations. Ion exchange is retained for further consideration.

2.5.4.4.6 Adsorption. Adsorbents such as activated carbon or organophillic clays can be used to remove constituents from groundwater. The typical adsorption system consists of pumping the impacted waste stream through one or more adsorbent columns or canisters. When the adsorption unit has exhausted its capacity for adsorption, it is removed and either disposed or regenerated. Compounds that can be effectively removed by carbon adsorption include VOCs, chlorinated hydrocarbons, polychlorinated biphenyls (PCBs), phenols, poly-nuclear aromatic hydrocarbons (PAHs), cyanide, and a few heavy metals. Organo-clays (anthracite mix) are capable of adsorbing oil, VOCs, SVOCs, chlorinated hydrocarbons, and heavy metals. Mixtures of organic constituents may cause reduced adsorption of a particular constituents due to the preferential adsorption of the other constituents. Pilot testing should be performed on the groundwater to be treated to determine the effectiveness of the process. Most of the cost of adsorption is replacing the spent adsorbent. Adsorbent is used in direct proportion to the concentration of the constituents and the flow rate of water treated. Adsorption at the Alpena CRTC sites should represent a relatively low cost. Adsorption is retained for further consideration.

2.5.4.4.6 Air Stripping. Air stripping uses the same principle as air sparging. Clean air is passed through VOC impacted water where the VOCs volatilize into the air and pass out of the water. This technology mainly treats VOCs, but can oxidize certain metals. Chief among these is calcium. The calcium oxidizes to calcium carbonate and is crystallized out on the air inlet ports, often plugging them. High levels of calcium in water usually result in the air stripping equipment requiring frequent maintenance. Water quality data collected during the RI indicates that the hardness (calcium) of the groundwater at Alpena CRTC sites is moderate. After the groundwater has been treated with air stripping, the air is impacted with VOCs. These compounds may need to be treated before the air is released to the atmosphere. Off-gas treatment equipment usually consists of carbon adsorption or catalytic oxidation. Air stripping is retained for further consideration.

2.5.4.4.7 Reverse Osmosis. Reverse osmosis is a process which concentrates organic constituents, salts, and metals while producing a clean water stream. Groundwater is pressurized and passed across a membrane. A portion of the groundwater and compounds with low molecular weights permeate the membrane. The remaining groundwater and other contaminants that do not pass through the membrane are concentrated and then discharged. Reverse osmosis is not a treatment process, but simply reduces the amount of contamination in the groundwater. Reverse osmosis is a proven technology, but requires costly capital outlay and O&M. Due to the fact that reverse osmosis is very costly and generates a waste stream, it is not retained for further consideration.

2.5.5 Disposal Actions

This option includes the disposal of soils and groundwater either prior to or after a treatment technology has been completed to reduce and/or eliminate the impacts to the media.

2.5.5.1 Soil. The two disposal options that are considered for the excavated soil include on-site disposal and off-site disposal at a landfill. On-site disposal is eliminated from further consideration because there are no adequate landfills at the Alpena CRTC. Any off-site disposal

of a potentially impacted soil may have future liability associated with it; therefore, off-site disposal is not retained further consideration.

2.5.5.2 Groundwater. Three discharge options were considered for disposal of the treated groundwater including WTF discharge, reinjection, and discharge to a surface water body such as the Thunder Bay River.

2.5.5.2.1 Wastewater Treatment Facility. Discharge to a WTF is limited by the quantity of water the facility is able to process. Flows greater than 30 gpm will tax the WTF. Investigation as to the acceptable discharge limits for metals through the facility's National Pollutant Discharge Elimination System (NPDES) permit will have to be investigated. This option involves modifications to the treatment facility including piping connections for the groundwater and additional monitoring to ensure compliance with permitted levels. Daily operations at the facility will be changed to include additional monitoring, maintenance, and operational costs. This option does not allow for sufficient capacity to be an effective option for discharging of groundwater, therefore, this option is not retained for further consideration.

2.5.5.2.2 Reinjection. Reinjection of groundwater can be considered if the returned water meets the drinking water standards and those of Michigan PA 451, Part 31. Reinjection wells are an effective and technically viable means of disposing of the treated groundwater. Reinjection is retained for further consideration.

2.5.5.2.3 Thunder Bay River. Discharging to the Thunder Bay River is an effective and inexpensive option. Discharging requires a NPDES permit. This involves some regulatory work and can be limited by naturally occurring levels of constituents in the river. This option includes a visible pipe that discharges the treated groundwater to the Thunder Bay River. This may present a poor public image for the base. In addition, the base will need to monitor the discharged groundwater to ensure compliance with the permit and assume liability for discharged groundwater that does not meet the permit. Due to the liabilities associated with this option and the image of the Alpena CRTC, this option will not be retained.

3.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

The next step in this FS is a further analysis of the technologies selected in Section 2.5. The technologies are combined into media specific alternatives which are screened based on effectiveness, implementability, and cost.

3.1 APPROACH TO DEVELOPMENT AND SCREENING OF ALTERNATIVES

As previously indicated, the process used in the preparation of this FS has been streamlined by direction of the ANG/CEVR. In an effort to reduce the number of technologies and alternatives screened during the preliminary steps of the FS process, the evaluations in Sections 2.0 and 3.0 of this FS report are performed for media specific categories, instead of for each individual site. The media specific categories evaluated in this section include organic constituents in soil, inorganic constituents in groundwater, and organic constituents in groundwater. These media specific categories are representative of the impacted media at the Alpena CRTC sites. The technologies retained in Section 2.5 are combined in this section to form alternatives for the three media specific categories. The alternatives for each of the media specific categories are screened based on effectiveness, implementability, and relative cost. The alternatives passing the screening in this section for each of the media specific categories are then combined into site specific alternatives in Section 4.0. The site specific alternatives are subject to a detailed analysis on a site by site basis in Section 4.0.

The three criteria used in the screening of the media specific alternatives in this section are defined as follows:

3.1.1 Effectiveness

The effectiveness of the alternative is assessed by evaluating whether the process option is adequate to protect human health and the environment and how quickly the protection is achieved. It should be noted that the human health and environmental risks at the Alpena CRTC sites are minimal. There are no sites that a pose a cancer risk above acceptable levels and only Site 1 poses an unacceptable non-cancer risk. Nevertheless, the evaluation in this section briefly

discusses the adequacy of each technology in limiting exposure (as defined in the RAOs) and protecting human health and the environment. This criterion also focuses on the compliance with ARARs and the degree to which the process option reduces toxicity, mobility, or volume of impacted media. The alternative is also evaluated to determine if the RAOs are met.

3.1.2 Implementability

The implementability of each alternative is evaluated by considering technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for the process option until remedial actions are complete. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies, and the requirements for, and availability of, specific equipment and technical specialties.

3.1.3 Relative Cost

The cost of implementing the remedial alternative is the final factor considered in the screening process. Since this section includes a general analysis based on the media specific categories and not on specific sites, no cost figures are presented in this section. The cost analysis in this section is a relative cost comparison of the alternatives presented in this section. Estimated costs are presented in Section 4.0 during the site by site analysis.

3.2 SCREENING OF ALTERNATIVES

This section includes the screening of media specific alternatives for the Alpena CRTC. The following sections describe in detail the screening of the alternatives.

3.2.1 Screening of Alternatives for Soils

The alternatives developed for the soils include only alternatives for treating organic constituents. Based on an analysis of the RI Report data, there are no sites which require remediation of inorganic constituents in the soils. No sites exhibit soil impacts in excess of Industrial Direct Contact Values. Based on an analysis of the BRA, no sites pose an unacceptable cancer risk and only Site 1 poses an unacceptable non-cancer risk. In addition, the soils at all of the sites have

been shown to be protective of groundwater. Therefore, the evaluation in this section focuses on the remediation of the unacceptable non-cancer risk at Site 1.

The alternatives evaluated for the organic constituents in soil include:

- No Action
- Limited Action - Natural Attenuation, Monitoring, and Institutional Controls
- In-situ Soil Treatment - Bio-Venting
- Aboveground Soil Treatment - Enhanced Volatilization

Table 3-1 contains a summary of screening completed in this section for the organic soil alternatives, including a listing of the alternatives retained for detailed analysis in Section 4.0. The screening process for each of the alternatives is discussed in detail in the following sections.

3.2.1.1 Alternative: No Action. The no action alternative serves as a baseline for comparison with the remedial alternatives. The no action alternative will include no monitoring, containment, or treatment of impacted soils.

3.2.1.1.1 Effectiveness. Under the no action alternative the toxicity, mobility, and volume of the soil impacts will not be reduced. There will be no reduction in the non-cancer risk to human health. This alternative will not meet RAOs for soil. This alternative will comply with ARARs for soils since the soil impacts have been shown to be protective of groundwater and the detected concentrations of the constituents are not above Industrial Direct Contact Values.

3.2.1.1.2 Implementability. There are no actions to implement under this alternative.

3.2.1.1.3 Costs. There is no cost associated with the no action alternative.

The no action alternative is retained for further analysis for a baseline comparison.

TABLE 3-1
Summary of Screening for Organic Impacts to Soil
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Effectiveness	Implementability	Relative Cost	Screening Result
No Action	MTV[a] not reduced. Does not meet RAOs. Meets soil ARARs.	No action to implement.	No cost	Retained[b]
Limited Action Institutional Controls/ Natural Attenuation	T and V will be reduced, M is not reduced. Meets RAOs in long-term. Will provide overall protection of human health and the environment once natural attenuation occurs. Meets ARARs.	All actions are technically feasible and easily implemented.	Low Cost	Retained[b]
In-Situ Soil Treatment Bio-Venting	T and V are reduced, M is not reduced for non-halogenated constituents. This alternative is ineffective on halogenated organic constituents. Meets ARARs. Overall, this alternative will not meet RAOs due to ineffectiveness on halogenated organic constituents. Will not treat chlorobenzene to reduce the non-cancer risk at the Site 1.	All actions are technically feasible. Uses common materials and readily available equipment. Pilot scale testing will be required.	Low to moderate cost	Not Retained
Aboveground Soil Treatment Enhanced Volatilization	MTV reduced. Meets ARARs and all RAOs. Provides overall protection of human health and the environment.	All actions are technically feasible. Uses readily available materials and processing equipment. Pilot scale testing will be required.	Moderate cost	Retained

Notes:
a) M=mobility, T=toxicity, V=volume
b) Under direction of ANG/CEVR, these options will be retained for the detailed analysis.

3.2.1.2 Alternative: Limited Action - Natural Attenuation, Monitoring, and Institutional Controls. Under the limited action alternative, the constituents in the soil will not be contained or treated, but monitored for natural attenuation. This alternative includes further characterization to define the soil impacts. In addition, this alternative will include pre-design testing to verify the extent of the contamination. Institutional controls will be necessary to prevent construction activities until appropriate levels have been attained for the chlorobenzene in the soil. This alternative includes five-year reviews of the site until monitoring indicates that the site is protective of human health and the environment.

3.2.1.2.1 Effectiveness. The limited action alternative effectively will prevent human exposure to the constituents detected in the soil, thus meeting the RAO of protecting human health. This alternative does not involve active reduction of the toxicity, mobility, or volume of the soil impacts. As the soil contaminants naturally attenuate over time, there will be a reduction in the toxicity and volume of the impacts. The RAOs will be met in the long-term as the natural attenuation process occurs. This alternative meets ARARs.

3.2.1.2.2 Implementability. All activities required under this alternative are technically feasible. Long-term monitoring of soil and five-year site reviews are easily implemented. It is anticipated that the MIANG can enact and enforce all required institutional controls needed to implement this alternative.

3.2.1.2.3 Costs. The cost for this alternative will include pre-design activities, soil sampling, the five-year reviews, and institutional controls. The cost for this alternative will be minimal compared to treatment options for organic constituents in soil.

This alternative provides a cost effective means for remediating site impacts while providing protection of human health. The level and type of impacts at the Alpena CRTC sites are strong candidates for natural attenuation. The limited action alternative with natural attenuation is retained for further analysis.

3.2.1.3 Alternative: In-situ Soil Treatment - Bio-Venting. The bio-venting (bio-degradation) alternative uses a network of shallow wells in the vadose zone (unsaturated) to inject air at a rate suitable to enhance bio-degradation, but not high enough to cause active volatilization. The aerobic bio-degradation process, which bio-venting aids in, will destroy non-halogenated organic constituents over a period of time. This alternative will include pre-design activities to verify the extent of the soil contamination. Monitoring of the soil during the treatment process will be necessary to track the constituents as they degrade. Institutional controls will be necessary to prevent construction activities until appropriate levels have been attained for the chlorobenzene. Five-year reviews are included in this alternative.

3.2.1.3.1 Effectiveness. Institutional controls will be effective in the short term for protection of human health. Bio-venting is a technology that has been proven to aid in aerobic bio-degradation of non-halogenated organic constituents and is a widely accepted technology for the destruction of non-halogenated organic constituents. The bio-venting technology will do little to aid the destruction of halogenated organic constituents. The organic constituents detected at Site 1 are the only constituents being evaluated under this alternative. The two constituents of concern at Site 1 are styrene and chlorobenzene. Bio-degradation should occur satisfactorily on non-halogenated styrene. Unfortunately, aerobic bio-degradation has been proven unreliable for treatment of halogenated compounds such as chlorobenzene. Bio-degradation will not reduce the concentration (toxicity or volume) of chlorobenzene, thus it will not reduce chlorobenzene's contribution to the non-carcinogenic HQ. Therefore, bio-venting will not meet soil RAOs. This alternative will comply with ARARs.

3.2.1.3.2 Implementability. Bio-venting uses common material for well construction and equipment that is readily available. The MDEQ accepts bio-venting for remediation of non-halogenated organic constituents. Conditions for bio-degradation at the Alpena CRTC sites such as temperature, pH, and nutrients fall within an acceptable range. It is anticipated that the MIANG can enact and enforce all required institutional controls. Pilot scale testing will be required during pre-design activities to verify the effectiveness of this alternative for specific conditions at the Alpena CRTC sites.

3.2.1.3.3 Costs. The cost associated with bio-venting will include the installation of the injection wells and associated equipment, pre-design activities, soil monitoring, and five-year site reviews. The cost of this alternative will be low to moderate compared to the aboveground treatment technologies.

Bio-venting will not reduce the concentration of the chlorobenzene at Site 1. Since the reduction of chlorobenzene is necessary to reduce the unacceptable non-cancer risk at the Site 1, bio-venting will not be retained for further consideration.

3.2.1.4 Alternative: Aboveground Soil Treatment - Enhanced Volatilization. Enhanced volatilization is the process where a constituent's natural tendency to vaporize into the air is utilized. Soil that contains volatile constituents is placed into a pug mill or soil shredder to increase the surface area of the soil. While in the pug mill, air is passed by the small soil particles and the constituents volatilize off the soil particles into the air. The air can then be discharged to the atmosphere or treated using either adsorption or incineration processes. Organic constituents with a low volatility can be treated by heating the air or the soil or both. Warming the air and soil increases the organic constituent's volatility. Confirmatory sampling will be completed during the remediation to verify that all constituents are removed from the soil.

Initially this alternative will include pre-design activities to verify the extent of the contaminated soil. Once the treatment is complete, this site will not require additional monitoring or sampling. A review of the site will be required every five years until treatment is complete.

3.2.1.4.1 Effectiveness. Enhanced volatilization is a recognized process for removing volatile organic constituents from soils. The toxicity, volume, and mobility of the organic constituents in the soil are reduced or eliminated, thus meeting all ARARs and RAOs for soils. Careful consideration will be given to the off-gas products so that they also meet applicable ARARs. Precautions will need to be taken during excavation to prevent worker exposure to non-cancer risks.

3.2.1.4.2 Implementability. Enhanced volatilization uses common readily available materials and processing equipment. Pilot scale testing will be required during pre-design activities to verify the effectiveness of this alternative for specific conditions at the Alpena CRTC sites.

3.2.1.4.3 Costs. The cost for this alternative will include pre-design activities, mobilization/demobilization, clearing and grubbing, excavation, soil treatment, and five-year reviews. Cost associated with this alternative will be moderate compared to other alternatives in this category.

Enhanced volatilization is a viable alternative for the removal of volatile constituents from soils. Therefore, enhanced volatilization is retained for further consideration.

3.2.2 Screening of Alternatives for Groundwater

The alternatives developed for groundwater include both alternatives for treating inorganic constituents and alternatives for treating organic constituents. In this section, the groundwater treatment technologies retained in Section 2.5 are evaluated separately for treatment of inorganic and organic impacts to groundwater. The groundwater technologies retained in Section 2.5 tend to be effective for either organic or inorganic constituents. The technologies are usually combined to treat groundwater impacted with both organic and inorganic constituents. For simplicity, this section presents the screening of the organic and inorganic groundwater treatment alternatives separately. This provides sufficient information to determine the most appropriate alternatives to retain for Section 4.0. In Section 4.0, the retained inorganic and organic groundwater alternatives are combined as needed for complete groundwater remediation at each site.

3.2.2.1 Inorganic Groundwater Alternatives. The alternatives evaluated for inorganic constituents in the groundwater include:

- No Action
- Limited Action - Natural Attenuation, Monitoring, and Institutional Controls
- Aboveground Groundwater Treatment - Adsorption
- Aboveground Groundwater Treatment - Ion Exchange

Table 3-2 contains a summary of screening completed in this section for the inorganic groundwater alternatives, including a listing of the alternatives retained for detailed analysis in Section 4.0. The following sections detail the screening process for each of the alternatives.

3.2.2.1.1 Alternative: No Action. The no action alternative serves as a baseline for comparison with the other alternatives. The RI Report BRA indicates that there are no unacceptable human health risks at any of the Alpena CRTC sites due to inorganic constituents in the groundwater. There are sites with constituents over the Industrial Drinking Water Values, but the groundwater at the Alpena CRTC is not used as a source of drinking water. Therefore, there are currently no complete pathways for the constituents in groundwater to reach humans. The no action alternative will include no monitoring, containment, or treatment of groundwater contamination.

Effectiveness. Under the no action alternative, the toxicity, mobility, and volume of groundwater impacts will not be reduced. Since the groundwater contamination will not be actively reduced in this alternative, and there will be no additional monitoring to show that natural attenuation is occurring, this alternative will not meet the ARARs and RAOs for sites with groundwater contamination in excess of Industrial Drinking Water Values. Although there are no plans to use groundwater in the future, this alternative will not provide measures to ensure that groundwater is not used in the future.

Implementability. There is no action to implement under this alternative.

TABLE 3-2
Summary of Screening for Inorganic Impacts to Groundwater
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Effectiveness	Implementability	Relative Cost	Screening Result
No Action	MTV[a] not reduced. Does not meet ARARs or RAOs for sites with groundwater impacts exceeding the Drinking Water Values.	No action to implement.	No costs	Retained[b]
Limited Action Institutional Controls/ Natural Attenuation	T and V will be reduced, M is not reduced. Meets ARARs and RAOs in long-term. Will provide overall protection of human health and the environment once natural attenuation occurs. Natural attenuation of inorganic constituents in groundwater is less likely than the natural attenuation of organic constituents.	All actions are technically feasible and easily implemented.	Low cost	Retained[b]
Aboveground Groundwater Treatment Adsorption	Pilot testing required to assure that this technology will be effective in capturing all metals MTV reduced if pilot testing is positive. Meets ARARs and RAOs (contingent on pilot test). Provides overall protection of human health and the environment (contingent on pilot test).	This technology is technically feasible.	Low cost	Not retained
Aboveground Groundwater Treatment Ion Exchange	MTV reduced. Meets ARARs and RAOs. Provides overall protection of human health and the environment.	This technology is technically feasible and has been widely used in past remedial activities. Alternative uses conventional materials and equipment. This option is more reliable than other technologies in this category. Bench scale testing will be required.	Moderate to high cost	Retained

Notes:
a) M=mobility, T=toxicity, V=volume
b) Under direction of ANG/CEVR, these options will be retained for the detailed analysis.

Costs. There is no cost associated with the no action alternative.

The no action alternative is retained for further analysis for comparison with other remedial alternatives. This alternative will be appropriate for sites which have been shown during field investigation not to have constituents in groundwater in excess of regulatory limits.

3.2.2.1.2 Alternative: Limited Action - Natural Attenuation, Monitoring, Institutional Controls. Under the limited action alternative groundwater contamination is not contained or treated, but monitored for natural attenuation and/or migration. Initially, this alternative will include pre-design activities to verify the extent of the groundwater contamination. This will include the installation of additional monitoring wells. In addition, this alternative will include periodic sampling of groundwater to monitor groundwater contamination. Institutional controls will be necessary to prevent the future use of groundwater of until appropriate levels have been attained. This alternative will include five-year reviews of the site.

Effectiveness. Through institutional controls, the limited action will effectively prevent human exposure to the impacted groundwater while natural attenuation is occurring. This alternative will include no active reduction the toxicity, mobility, or volume of groundwater contamination. Both adsorption and dilution will reduce the toxicity and volume of groundwater contamination. Monitoring will be necessary to confirm any natural attenuation. It is possible for inorganic constituents in groundwater to meet ARARs and RAOs through natural attenuation.

Implementability. All activities required under this alternative are technically feasible. Long-term monitoring of groundwater and five-year reviews can be easily implemented. It is anticipated that the MIANG can enact and enforce the institutional controls required for this alternative.

Costs. The cost for this alternative will include installation of additional wells, groundwater monitoring, five-year reviews, and any necessary institutional controls. The costs for this

alternative will be low compared to other treatment options for inorganic constituents in groundwater.

The limited action alternative with natural attenuation is retained for further analysis. This alternative will provide a cost effective means for remediating site impacts while providing protection of human health. The level and type of impacts at the Alpena CRTC sites are strong candidates for this alternative.

3.2.2.1.3 Alternative: Aboveground Groundwater Treatment - Adsorption. This alternative will include the extraction of groundwater through a network of wells or drains. Once extracted, groundwater will be treated on site using the liquid-phase adsorption process described in Section 2.5. Organo-clays generally perform best in removing inorganic constituents from groundwater. The inorganic constituents in the extracted groundwater will be adsorbed to the organo-clay until all of the adsorption sites on the clay are occupied. Spent organo-clay can be regenerated. After treatment, the groundwater will be reinjected into the aquifer.

Initially, this alternative will include pre-design activities to verify the extent of the contamination. This will include the installation of additional monitoring wells. In addition, this alternative will include monitoring of groundwater during remediation to assess treatment. Institutional controls will be necessary to prevent future use of groundwater until appropriate levels are met. Five-year reviews will be required until treatment is complete.

Effectiveness. Groundwater extraction wells are an effective and technically viable means of pumping groundwater to remove contaminant mass and control groundwater flow. Organo-clay adsorption has been shown to have a limited effect in removing metals from groundwater. Other groundwater treatment technologies have been demonstrated to be more effective and reliable in treating inorganic constituents in groundwater. The combined elements of this alternative will reduce the mobility, toxicity, and volume of constituents in the groundwater, thus meeting the groundwater RAOs and ARARs.

Implementability. Extraction wells have been commonly used in the past for removal of groundwater. Few major difficulties are expected to be encountered during construction and operation of the groundwater extraction and treatment system. Monitoring of the extraction and treatment system will be necessary to assess its reliability and performance. No difficulties are anticipated with short-term or long-term maintenance or replacement of site equipment or materials. Prior to remedial design, aquifer tests will need to be completed to assist in the development of a groundwater model. The groundwater model will be used in the development of the well network used for treatment.

Costs. The cost for this alternative will include pre-design activities, site preparation, groundwater modeling, groundwater injection permits, mobilization/demobilization, capital and operating costs for the network of wells, liquid-phase organo-clay adsorption treatment system, influent/effluent monitoring, continued groundwater monitoring, and five-year reviews. The cost associated with this alternative will be low compared to other treatment alternatives for groundwater.

The alternative is not retained for further consideration due to its limited effectiveness of metal removal.

3.2.2.1.4 Alternative: Aboveground Groundwater Treatment - Ion Exchange. Ion exchange uses resins to remove ionic species from water. Ionic species include metals in the groundwater. This process does not remove organic constituents which are non-ionic. Groundwater will be extracted from a network of wells. The collected groundwater will be sent to the ion exchange unit. After treatment, the groundwater will be reinjected into the aquifer.

Initially this alternative will include pre-design activities to verify the extent of the contamination. This will include the installation of additional monitoring wells. In addition, this alternative will include monitoring groundwater during remediation to assess the treatment. Institutional controls will be necessary to prevent future use of groundwater until appropriate levels are met. Five-year reviews will be required until appropriate levels are met.

Effectiveness. This alternative will be effective in removing metals and therefore reducing the volume, toxicity, and mobility of the metals in the groundwater. The process is capable of meeting all of the requirements of the ARARs and RAOs applying to groundwater.

Implementability. Ion exchange has been used extensively by industry and in remediation projects. The resins and equipment are readily available commercially. Bench scale testing will be required during pre-design activities to verify the effectiveness of this alternative for specific conditions at the Alpena CRTC sites.

Costs. Cost for this alternative will include pre-design activities, site preparation, groundwater modeling, groundwater injection permits, capital and operating costs for the network of wells, mobilization/demobilization, ion exchange treatment system, influent/effluent monitoring, continued groundwater monitoring, and five-year reviews. Ion exchange will be moderately expensive compared to other low flow rate metals removal technologies.

Even though the ion exchange alternative is moderately expensive, it is the most reliable alternative for treating inorganic impacts to groundwater and is retained for further consideration.

3.2.2.2 Organic Groundwater Alternatives. The alternatives evaluated for organic constituents in groundwater include:

- No Action
- Limited Action - Natural Attenuation, Monitoring, and Institutional Controls
- In-situ Treatment- Air-Sparging
- Aboveground Groundwater Treatment - Adsorption
- Aboveground Groundwater Treatment - Air Stripping

Table 3-3 contains a summary of screening completed in this section for the organic groundwater alternatives, including a listing of the alternatives retained for detailed analysis in Section 4.0. The following sections detail the screening process for each of the alternatives.

TABLE 3-3
Summary of Screening for Organic Impacts to Groundwater
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Effectiveness	Implementability	Relative Cost	Screening Result
No Action	MTV[a] not reduced. Does not meet ARARs or RAOs.	No action to implement.	No costs	Retained[b]
Limited Action Institutional Controls/ Natural Attenuation	T and V will be reduced, M is not reduced. Meets ARARs and RAOs in long-term. Will provide overall protection of human health and the environment once natural attenuation occurs.	All actions are technically feasible and easily implemented.	Low cost	Retained[b]
In-situ Air-sparging	T and V are reduced, M is not reduced for non-halogenated constituents. This alternative is ineffective on halogenated organic constituents. Meets ARARs and RAOs for halogenated organic constituents.	This technology is technically feasible for treating halogenated hydrocarbons in-situ. The option requires common materials and readily available equipment. Pilot scale test will be required.	Low to moderate cost	Retained
Aboveground Groundwater Treatment Adsorption	MTV reduced. Meets ARARs and RAOs. Provides overall protection of human health and the environment. Possible liabilities associated with spent GAC units.	This technology is technically feasible for treating organic constituents in groundwater. The option requires common materials and readily available equipment. Groundwater modeling required.	Moderate cost	Not retained
Aboveground Groundwater Treatment Air Stripping	MTV reduced. Meets ARARs and RAOs. Provides overall protection of human health and the environment.	This is a well developed technology which will be effective on the organic impacts at this sites. The option requires common materials and readily available equipment. Groundwater modeling required.	Moderate cost	Retained

Notes:
a) M=mobility, T=toxicity, V=volume
b) Under direction of ANG/CEVR, these options will be retained for the detailed analysis.

3.2.2.2.1 Alternative: No Action. The no action alternative serves as a baseline for comparison with the other alternatives. The RI Report BRA indicates that there are no unacceptable human health risks at any of the Alpena CRTC sites due to organic constituents in the groundwater. There are sites with constituents over the Industrial Drinking Water Values, but the groundwater at the Alpena CRTC is not currently used as a source of drinking water. Therefore, there are no complete pathways for the constituents in groundwater to reach humans. The no action alternative will include no monitoring, containment, or treatment of groundwater contamination.

Effectiveness. Under the no action alternative, the toxicity, mobility, and volume of groundwater contamination will not be actively reduced. Since the groundwater impacts will not be actively reduced in this alternative and there will be no additional monitoring to assess natural attenuation of the contamination, the ARARs and RAOs will not be met for sites with groundwater impacts in excess of Industrial Drinking Water Values. Although there are no plans to use groundwater in the future, this alternative will not provide measures to ensure that groundwater is not used in the future.

Implementability. There is no action to implement under this alternative.

Costs. There is no cost associated with the no action alternative.

The no action alternative is retained for further analysis for comparison with other alternative. This alternative will be appropriate for sites which have been shown during field investigation not to have constituents in excess of regulatory limits.

3.2.2.2.2 Alternative: Limited Action - Natural Attenuation, Monitoring, and Institutional Controls. Under the limited action alternative groundwater contamination will not be contained or treated, but monitored for natural attenuation and/or migration. Initially, this alternative will include pre-design activities to verify the extent of the groundwater contamination. This will include the installation of additional monitoring wells. In addition, this alternative will

include monitoring of groundwater during remediation to assess the natural attenuation process. Institutional controls will be necessary to prevent future use of groundwater until appropriate levels have been attained. This alternative will include five-year reviews of the site.

Effectiveness. Through institutional controls, the limited action will effectively prevent exposure to the impacted groundwater during remediation activities. There will be no active reduction the toxicity, mobility, or volume of the groundwater contamination in this alternative. The constituents in the groundwater will naturally attenuate to levels meeting ARARs and RAOs. As the constituents naturally attenuate there will be a reduction in the toxicity and volume of the contamination.

Implementability. All activities required under this alternative are technically feasible. Long-term monitoring of groundwater and five-year reviews will be easily implemented. It is anticipated that the MIANG will be able to enact and enforce all institutional controls required for this alternative.

Costs. The cost for this alternative will include pre-design activities, sampling, five-year reviews, and any necessary institutional controls. Costs for this alternative will be low compared with treatment alternatives for organic constituents in soil.

This alternative will provide a cost effective means for remediating site impacts while providing protection of human health. The level and type of contamination at the Alpena CRTC sites are strong candidates for natural attenuation. The limited action alternative with natural attenuation is retained for further analysis.

3.2.2.2.3 Alternative: In-Situ Treatment - Air-Sparging. The air-sparging alternative uses a network of shallow wells in the aquifer to inject air at a rate suitable to involve aerobic bio-degradation, but not high enough to cause active volatilization. The aerobic bio-degradation process will destroy non-halogenated organic constituents over a period of time.

Initially this alternative will include pre-design activities to verify the extent of the contamination. This will include the installation of additional monitoring wells. In addition, this alternative will include monitoring of groundwater during remediation to assess the treatment. Institutional controls will be necessary to prevent the future use of groundwater until appropriate levels are met. Five-year reviews will be required until treatment is complete.

Effectiveness. Air-sparging is a technology that has been proven to aid in aerobic bio-degradation of contaminants. Aerobic bio-degradation is a widely accepted technology for the destruction of non-halogenated organic constituents. The toxicity and volume of the contamination are reduced using air-sparging/bio-degradation for non-halogenated constituents; however, the alternative has no effect on the mobility of the contaminants. Air-sparging can also aid in bio-degradation in the vadose zone as unused oxygen can be utilized by biological activity in the vadose zone. With time, air-sparging meets ARARs and RAOs for non-halogenated organic constituents.

Implementability. Bio-sparging uses common material for well construction and equipment that is readily available. Conditions for bio-degradation at the Alpena CRTC sites such as temperature, pH, and nutrients fall within an acceptable range. Pilot scale testing will be required during pre-design activities to verify the effectiveness of this alternative for specific conditions at the Alpena CRTC sites.

Costs. The cost associated with air-sparging will include pre-design activities, installation of the sparge wells and associated equipment, groundwater monitoring, and five-year site reviews. The cost of this alternative will be low compared to other alternatives in this category.

Air-sparging is retained for further consideration.

3.2.2.2.4 Alternative: Aboveground Treatment - Adsorption. This alternative includes the extraction of groundwater through a network of wells or drains. Once extracted, groundwater will be treated on-site using the liquid-phase adsorption process described in Section 2.5. For organic constituents in groundwater GAC generally performs best. The organic constituents in the extracted groundwater will be adsorbed to the GAC until all of the adsorption sites on the carbon are occupied. Spent GAC can be regenerated. After treatment, the groundwater will be reinjected into the aquifer.

Initially this alternative will include pre-design activities to verify the extent of the groundwater contamination. This will include the installation of additional monitoring wells. In addition, this alternative will include monitoring of groundwater during remediation to assess the treatment. Depending on specific site conditions, institutional controls may be necessary to prevent future use of groundwater until appropriate levels are met. Five-year reviews will be required until treatment is complete.

Effectiveness. Groundwater extraction wells are an effective and technically viable means of pumping groundwater to remove contaminant mass and control groundwater flow. GAC adsorption has been demonstrated effective in removing VOCs from groundwater. However, spent GAC units must be either shipped off-site creating a potential liability or regenerated. The combined elements of this alternative will provide protection to human health and the environment by reducing the mobility, toxicity, and volume of constituents in the groundwater. This alternative will meet ARARs and RAOs.

Implementability. Extraction wells have been commonly used in the past for extraction of groundwater. Few major difficulties are expected to be encountered during construction and operation of the groundwater extraction and treatment system. Monitoring of the extraction and treatment system will be necessary to assess its reliability and performance. Prior to remedial design, aquifer tests will need to be completed to assist in the development of a groundwater model. The groundwater model will be used in the development of the well network used for treatment.

Costs. The cost for this alternative will include pre-design activities, site preparation, groundwater modeling, groundwater injection permits, mobilization/demobilization, capital and operating costs for the network of wells, liquid-phase GAC adsorption treatment system, replacement GAC units, influent/effluent monitoring, continued groundwater monitoring, and five-year reviews. The costs for this alternative will be moderate compared with other alternatives for treating organic constituents in groundwater.

This alternative is not retained for further analysis in Section 4.0. Air stripping is an equally effective treatment technology which does not create a waste stream requiring disposal.

3.2.2.2.5 Alternative: Aboveground Treatment - Air Stripping. This alternative involves the extraction of groundwater through a series of wells. This alternative consists of treating the extracted groundwater with an air stripping system. The air stripping system consists of a horizontal tray or packed column in which the groundwater flows downward and films on the tray openings or packing contacting upward flowing air. VOCs are transferred from the water phase to the air phase in the tower. After treatment, the groundwater will be reinjected into the aquifer.

Initially this alternative will include pre-design activities to verify the extent of the contamination. This will include the installation of monitoring wells. In addition, this alternative will include monitoring of groundwater during remediation to assess the treatment. Institutional controls will be necessary to prevent the use of groundwater until appropriate levels are met. Five-year reviews will be required until treatment is complete.

Effectiveness. The groundwater extraction wells are an effective and technically viable means of extracting groundwater. Air stripping has been proven effective in removing VOCs from extracted groundwater. Air stripping will be effective in reducing volume, toxicity, and mobility of the impacted media. ARARs and RAOs will be met under this alternative.

Implementability. Extraction well systems have been commonly used in the past for removal of impacted groundwater. Few difficulties are expected to be encountered during

Implementability. Extraction well systems have been commonly used in the past for removal of impacted groundwater. Few difficulties are expected to be encountered during construction and operation of the groundwater extraction and treatment system. Air stripping is a well developed technology and has been used to treat VOCs in groundwater at many sites across the country. Monitoring of the extraction and treatment system will be necessary to assess its reliability and performance. Prior to remedial design, aquifer tests will need to be completed to assist in the development of a groundwater model. The groundwater model will be used in the development of the well network used for treatment and in sizing the air stripping unit.

Costs. The cost for this alternative will include pre-design activities, site preparation, groundwater modeling, groundwater injection permits, mobilization/demobilization, capital and operating costs for construction of a network of extraction wells, air stripping treatment, influent/effluent monitoring, continued groundwater monitoring, and five-year reviews. The cost for this alternative will be moderate relative to other treatment options for organic constituents in groundwater.

This alternative is retained for further analysis in Section 4.0.

4.0 DETAILED ANALYSIS OR ALTERNATIVES

In this section, the media specific alternatives retained in Section 3 are combined into site specific alternatives for each of the sites at the Alpena CRTC. The site specific alternatives are subject to a detailed analysis using the USEPA's nine criteria for evaluating remedial alternatives.

4.1 INTRODUCTION

This FS report has been streamlined by generalizing the steps that lead to the detailed analysis of the remedial alternatives. To this point, the FS has been based on media specific categories developed for the Alpena CRTC. The detailed analysis completed in this section is presented individually for each of the Alpena CRTC sites. The analysis is intended to provide decision-makers with sufficient information to select the appropriate remedial actions for each site.

The following is a summary list of the alternatives developed for each of the sites at the Alpena CRTC.

Site 1	Alternative	Action
	1-1	No Action
	1-2	Limited Action (Natural Attenuation, Monitoring, and Restrictions)
	1-3	Limited Action for Soils (Natural Attenuation, Monitoring, and Restrictions) and Aboveground Groundwater Treatment (Air Stripping and Ion Exchange)
	1-4	Aboveground Soil Treatment (Enhanced Volatilization) and Aboveground Groundwater Treatment (Air Stripping and Ion Exchange)

Site 3	Alternative	Action
	3-1	No Action
	3-2	Limited Action for Groundwater and Soil (Natural Attenuation and Monitoring)

Site 5	Alternative	Action
	5-1	No Action
	5-2	Limited Action for Groundwater (Natural Attenuation, Monitoring, and Restrictions)
	5-3	In-Situ Groundwater Treatment (Air-Sparging)
	5-4	Aboveground Groundwater Treatment (Air Stripping)

Sites 6 & 7	Alternative	Action
	6/7-1	No Action
	6/7-2	Limited Action for Groundwater and Soil (Natural Attenuation and Monitoring)

Site 8	Alternative	Action
	8-1	No Action
	8-2	Limited Action for Groundwater and Soil (Natural Attenuation and Monitoring)

Site 9	Alternative	Action
	9-1	No Action
	9-2	Limited Action for Groundwater and Soil (Natural Attenuation and Monitoring)
	9-3	Aboveground Groundwater Treatment (Air Stripping and Ion Exchange)

4.2 ASSESSMENT CRITERIA

The detailed evaluation of the alternatives in this section will be based on the nine criteria as directed by USEPA (USEPA, 1988): short-term effectiveness; long-term effectiveness; implementability; cost; reduction of toxicity, mobility, or volume; compliance with ARARs; overall protection of human health and the environment; state acceptance; and community acceptance. The criteria are considered individually and are equally weighted for importance. These criteria are explained in detail in the following paragraphs.

4.2.1 Short-Term Effectiveness

This criterion includes an evaluation of the effectiveness of an alternative in protecting human health and the environment during the construction and implementation of a remedy until the response objectives are met.

4.2.2 Long-Term Effectiveness and Permanence

This analysis evaluates long-term effectiveness of the alternative with respect to the permanence of the alternative, whether the RAOs are met, the magnitude of residual risk, and the adequacy and reliability of controls used to manage remaining waste over the long term.

4.2.3 Overall Protection of Human Health and Environment

The analysis includes an evaluation of how the alternative achieves and maintains overall protection of human health and the environment, including if the alternative reduces the risk from potential exposure pathways through treatment, engineering, and/or institutional controls.

4.2.4 Implementability

Under this criterion, the alternative is evaluated for the technical and administrative implementability of the alternative and the availability of the goods and services needed to implement it.

4.2.5 Cost

The alternative is evaluated in terms of its estimated 30-year present worth costs, which includes both capital costs, indirect costs, operation and maintenance costs, and review costs. A discount rate of 7 percent will be used in the estimates. An accuracy range of +50 percent to -30 percent is attempted for all the cost estimates.

4.2.6 Reduction of Mobility, Toxicity, or Volume

The remedial alternative is evaluated against the anticipated performance of the proposed treatment technologies.

4.2.7 Compliance with ARARs

Under this criterion, the alternative is evaluated in terms of its compliance with Federal and state ARARs, or if a waiver is required and how the waiver is justified.

4.2.8 State Acceptance

This criterion reflects the state's apparent preferences among, or concerns about, each alternative. State acceptance will be determined after review of this FS by the MDEQ.

4.2.9 Community Acceptance

This criterion reflects the community's apparent preferences among, or concerns about, each alternative. As community involvement has yet to be solicited in the evaluation of alternatives, community acceptance of alternatives will be determined at a later date. Community acceptance criteria will not be included with each alternative until the community has been solicited to review the feasibility study.

4.3 ANALYSIS OF ALTERNATIVES FOR SITE 1

Remedial action alternatives for Site 1 soil and groundwater are presented below. Site 1 is the planned future location of the Alpena CRTC headquarters. The construction requirements of the headquarters are accounted for in the evaluation of the remedial alternative at this site. Table 4-1 summarizes the results of the analysis of Site 1 alternatives.

4.3.1 Alternative 1-1: No Action

The no action alternative serves as a baseline for comparison with other remedial alternatives. Under this alternative, no remedial actions will be performed at Site 1 to contain or reduce the contaminants detected in the soil and groundwater. An assessment of Alternative 1-1 follows:

4.3.1.1 Short-Term Effectiveness. This alternative will be ineffective in the short-term in preventing human exposure to the soil or groundwater contamination at Site 1. Excavation workers conducting construction activities at the site could be exposed to unacceptable non-cancer risks.

4.3.1.2 Long-Term Effectiveness. This alternative will be ineffective over the long-term. The no action alternative will not meet the RAOs presented in Section 2.3 for groundwater or soil. Although groundwater is not currently used at the Alpena CRTC and its use is not planned in the future, this alternative will not prevent potential future use of the groundwater at this site. Workers conducting construction activities at the site could be potentially exposed to unacceptable non-cancer risks.

4.3.1.3 Overall Protection of Human Health and the Environment. Under this alternative, no action will be taken to reduce and/or prevent the potential for human exposure to contamination or for protection of the environment. Workers completing construction activities at the site could potentially be exposed to an unacceptable non-cancer risk.

TABLE 4-1
Comparative Analysis of Remedial Alternatives for Site 1
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Estimated Cost[a]	Overall Protection of Human Health and the Environment	Implementability	Reduction of Toxicity, Mobility, and Volume	Compliance with ARARs and RAOs
1-1 No Action	$0	No actions will be taken to protect human health or the environment.	No actions to implement.	No active reduction in MTV[b] for soil or groundwater constituents.	Will not be able to prove compliance with ARARs or RAOs. Currently meets ARARs, will not be able to prove compliance with RAOs.
1-2 Limited Action (Natural Attenuation/Monitoring/ Restrictions)	$76,236 to $163,353	Once natural attenuation of contaminants occurs, this alternative will provide overall protection of human health and the environment Deed restrictions will protect human health during the attenuation of constituent levels.	All activities planned under this alternative are easily implemented. Long-term institutional management, monitoring, and 5-year reviews will be required.	No active reduction in MTV. As constituents levels naturally attenuate there will be reduction in MTV. Monitoring will provide information for assessment of reduction in TV.	As groundwater contaminant levels naturally attenuate, the groundwater will meet ARARs and RAOs. Soils currently meet ARARs. Once attenuation occurs soils will meet RAOs.

TABLE 4-1 (Continued)
Comparative Analysis of Remedial Alternatives for Site 1
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Estimated Cost[(a)]	Overall Protection of Human Health and the Environment[(b)]	Implementability	Reduction of Toxicity, Mobility, and Volume	Compliance with ARARs and RAOs
1-3 Limited Action for Soil (Natural Attenuation/ Monitoring/Restrictions) and Aboveground Groundwater Treatment (Air Stripping/Ion Exchange)	$434,113 to $930,242	Once natural attenuation of soil contaminant levels and treatment of groundwater contaminants occurs, this alternative will provide overall protection of human health and the environment. Deed restrictions will protect human health during the remediation activities.	All activities planned under this alternative are readily implemented. Long-term institutional management, monitoring, and 5-year reviews will be required. Bench scale testing (for ion exchange) and system pumping test will be required.	No active reduction in MTV for soil constituents. As constituent levels in soil naturally attenuate, there will be a reduction in MTV. Monitoring of soil will provide information for assessment of the reduction of MTV for soil constituents. Groundwater treatment will result in active reduction of MTV.	Soils currently meet ARARs. Once attenuation occurs, soils will meet RAOs. Once treated, the groundwater will meet ARARs and RAOs.
1-4 Aboveground Soil Treatment (Enhanced Volatilization) and Aboveground Groundwater Treatment (Air Stripping/Ion Exchange)	$546,062 to $1,171,320	Once treatment occurs, this alternative will provide overall protection of human health and the environment. Deed restrictions will protect human health during the remediation activities.	All activities planned under this alternative are readily implemented. Long-term institutional management, monitoring, and 5-year reviews will be required. Pilot testing (for enhanced volatilization), bench scale testing (for the ion exchange), and a system pumping test will be required.	Will provide active reduction of MTV for both soil and groundwater	Soils currently meet ARARs. Once treated the soils will meet RAOs Once treated the groundwater will meet ARARs and RAOs.

Notes:
(a) Present worth cost is calculated based on a 7 percent discount rate over the duration of the alternative.
(b) M=mobility, T=toxicity, V=volume

4.3.1.4 Implementability. The technical and administrative feasibility of Alternative 1-1 and the availability of the goods and services needed to implement it are as follows:

4.3.1.4.1 Technical Feasibility. There are no actions to implement under this alternative.

4.3.1.4.2 Administrative Feasibility. There are no actions to implement under this alternative.

4.3.1.4.3 Availability of Services and Materials. No construction materials or contracting services will be required to implement this alternative.

4.3.1.5 Cost. There is no cost associated with this alternative.

4.3.1.6 Reduction of Toxicity, Mobility, or Volume. The no action alternative will not result in active reduction of toxicity, mobility, or volume of impacts. Although there will be natural attenuation of groundwater and soil constituent levels, the no action alternative will not provide any mechanism to monitor this attenuation of constituents.

4.3.1.7 Compliance with ARARs. The no action alternative will not meet ARARs for groundwater. ARARs for soils are met because the constituents detected in the soil have been shown not to leach to groundwater, and the constituent concentrations do not exceed Industrial Direct Contact Values.

4.3.2 Alternative 1-2: Limited Action

Under the limited action alternative, the soil and groundwater contaminants will not be contained or treated, but rather monitored as they naturally attenuate. Initially, this alternative will include pre-design activities to verify the extent of the contamination in the soil and groundwater. Although the groundwater is not used as a drinking source, institutional controls will be necessary to ensure that the groundwater is not used until the constituent levels are below ARARs.

Institutional controls will also be necessary to ensure that construction workers are not exposed to the chlorobenzene until the associated non-cancer risk is at an acceptable level. Monitoring of groundwater and soil will assess the natural attenuation of the contamination. It is expected that the limited action alternative will require 10 years for attenuation of the site contamination to levels below regulatory limits. In addition, five-year reviews will be completed to assess the site impacts during the 10 years of natural attenuation. An assessment of Alternative 1-2 follows:

4.3.2.1 Short-Term Effectiveness. Institutional controls will be effective in reducing the likelihood of human exposure to soil and groundwater impacts at the site while the contaminant levels are attenuating. Groundwater is currently not used and it is not expected to be used as a drinking water source at the Alpena CRTC. Therefore, groundwater use should not be an issue. If construction activities are completed in the vicinity of the chlorobenzene before the non-cancer risk decreases to an acceptable level, workers will need to follow safety procedures and wear appropriate protective equipment to reduce exposure to the soil contamination. Sampling of soil and groundwater will effectively monitor attenuation.

4.3.2.2 Long-Term Effectiveness. This alternative will be effective over the long-term for soil and groundwater contamination.

The levels of organic constituents in the soil will naturally attenuate over time. The constituent levels detected in the soil have been shown to be protective of groundwater since none of the constituents detected in the soil have been detected in the groundwater samples in excess of Industrial Drinking Water Values. In addition, none of the constituent levels detected in the soil are in excess of Industrial Direct Contact Values. Once soil sampling indicates that the level of chlorobenzene has decreased to a concentration that no longer poses a health risk, there will be no additional remedial actions required for the Site 1 soils.

The groundwater contamination concentrations will naturally attenuate over time.

The limited action alternative will meet the RAOs presented in Section 2.3 for soils and groundwater. Long-term monitoring will provide an effective means for monitoring the natural attenuation at the site.

4.3.2.3 Overall Protection of Human Health and the Environment. The institutional controls in this limited action alternative will provide protection of human health and prevent exposure to the constituents in the soil and groundwater while attenuation is taking place. Monitoring will track the concentration of antimony in the groundwater that may be flowing into the river to verify that it does not exceed GSI values. As the groundwater constituent levels attenuate to below Industrial Drinking Water Values, this alternative will provide overall protection of human health and the environment.

4.3.2.4 Implementability. The technical and administrative feasibility of Alternative 1-2 and the availability of the goods and services needed to implement it are as follows:

4.3.2.4.1 Technical Feasibility. All site activities planned under this alternative are technically feasible. The soil and groundwater monitoring and the five-year reviews required for this alternative are easily implemented.

4.3.2.4.2 Administrative Feasibility. Considerable long-term institutional management is associated with the alternative because the contaminants remain on-site. Institutional controls are easily implemented as the MIANG has exclusive use of the property.

4.3.2.4.3 Availability of Services and Materials. Materials are readily available for the installation of additional monitoring wells. Contractor services are readily available to complete pre-design sampling activities, monitoring of groundwater and soil, and the five-year reviews.

4.3.2.5 Cost. The cost associated with this alternative is presented in Table 4-2. Assuming a 7 percent discount rate, the 10-year, present-worth cost for this alternative is $108,902 (-30 to +50 percent). Assumptions for the cost estimate are in Appendix A-1.

TABLE 4-2
Cost Estimate for Alternative 1-2: Limited Action
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS (DDC)				
Institutional Controls (a)	1	lump sum		$15,000
PRE-DESIGN ACTIVITIES				
Work Plan/Sampling Plan (l)	1	lump sum		$4,000
Well Installation (b)	1	lump sum		$1,500
Groundwater Sampling (g)	1	lump sum		$5,000
Soil Sampling (h)	1	lump sum		$10,000
INDIRECT CAPITAL COSTS				
Contingency (a)	1	lump sum		$5,000
		TOTAL CAPITAL COSTS		$40,500
ANNUAL MONITORING COSTS				
MONITORING				
Groundwater Monitoring (c)	1	yearly		$8,000
		TOTAL ANNUAL COSTS		$8,000
FIVE-YEAR COSTS				
MONITORING				
Soil Monitoring (i)	1	lump sum		$4,500
SITE REVIEWS				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,500
Report Preparation	1	lump sum		$1,500
		FIVE YEAR REVIEW COSTS		$10,000
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	10	years (o)		
		TOTAL PRESENT WORTH		$108,902

Assumptions for this cost estimate are located in Appendix A-1

4.3.2.6 Reduction of Toxicity, Mobility, or Volume. The limited action alternative does not actively reduce the toxicity, mobility, and volume of the contaminants. As natural attenuation occurs, there will be a reduction in the toxicity, mobility, or volume of contaminants. The sampling/monitoring of soils and groundwater will allow for an assessment of contaminants as the natural attenuation process occurs.

4.3.2.7 Compliance with ARARs. As contaminant levels in the groundwater naturally attenuate, the groundwater will meet ARARs. Since the soil has been shown to be protective of groundwater and because constituents were not detected in soil samples above the Industrial Direct Contact Values, the soil meets ARARs.

4.3.3 Alternative 1-3: Limited Action for Soil (Natural Attenuation, Monitoring, and Restrictions) and Aboveground Groundwater Treatment (Air Stripping and Ion Exchange)

Under Alternative 1-3, the soil contaminants will not be contained or treated, but rather monitored as they naturally attenuate. Institutional controls will be implemented to prevent construction worker exposure to the chlorobenzene until the associated non-cancer risk is at an acceptable level. Pre-design activities will be completed to verify the extent of the groundwater and soil contamination. Monitoring of soil will assess the natural attenuation of the contamination.

This alternative will include treating the groundwater using an air stripper system to remove the benzene and an ion exchange unit to remove the antimony. This alternative will include the installation of additional monitoring wells to verify the extent of the groundwater contamination. For the groundwater treatment system, wells will be installed to extract groundwater. Once extracted, the groundwater will be routed through the air stripper and then the ion exchange unit. Both the influent and effluent streams of the treatment system will be monitored and analyzed regularly. The treated groundwater will be reinjected into the aquifer. Groundwater modeling will be required to determine the exact placement of the extraction and reinjection wells. Based on hydrogeologic information presented in the RI Report and professional experience in designing

groundwater extraction systems at sites with similar hydrogeological characteristics, the estimated groundwater extraction rate for Site 1 will be between 5 and 15 gpm. Additional pre-design activities for this alternative will include a bench scale test for the ion exchange system and a system pump test. During remediation, groundwater will be monitored annually to assess the performance of the groundwater treatment. It is expected that this alternative will require 10 years for remediation of contaminants to levels below regulatory limits. Five-year reviews will be completed to assess the site during the 10 years of remediation. An assessment of Alternative 1-3 follows:

4.3.3.1 Short-Term Effectiveness. Institutional controls will be effective in reducing the potential for human exposure to soil and groundwater contaminants at the site while remediation activities are taking place. Groundwater is currently not used, nor is it expected to be used as a drinking source; therefore, groundwater use should not be an issue. If construction activities are completed in the vicinity of the chlorobenzene before the non-cancer risk decreases, workers will need to follow safety procedures and wear appropriate protective equipment to reduce exposure to the contaminants. Soil sampling will provide information necessary to effectively assess the natural attenuation of constituent levels in the soil. The groundwater treatment activities should pose no unacceptable health risk to workers or the environment during remediation activities.

4.3.3.2. Long-Term Effectiveness. This alternative will be effective over the long-term in treating contamination at the site and preventing risks to human health and the environment.

The levels of organic constituents in the soil will naturally attenuate over time. Constituent levels detected in the soil have been shown to be protective of groundwater since none of the constituents were detected in the groundwater samples at concentration levels in excess of Industrial Drinking Water Values. In addition, none of the constituent concentrations detected in the soil exceed the Industrial Direct Contact Values. Once soil sampling shows that the level of chlorobenzene has decreased to a concentration that no longer poses a health risk, there will be no additional remedial actions required for the Site 1 soils. This alternative will meet the RAOs established for soil in Section 2.3.

This alternative will also be effective in treating the groundwater and reducing the contamination in the groundwater. This alternative will meet the RAOs established for groundwater in Section 2.3.

4.3.3.3 Overall Protection of Human Health and the Environment. This alternative will be effective in overall protection of human health and the environment. Institutional controls will be the initial means of protecting human health during remediation activities. Once the actions have been completed for this alternative, Site 1 soil and groundwater will pose no risk to human health or the environment.

4.3.3.4 Implementability. Technical and administrative feasibility of Alternative 1-3 and the availability of the goods and services needed to implement it are as follows:

4.3.3.4.1 Technical Feasibility. Site activities planned under this alternative are technically feasible and readily implemented.

4.3.3.4.2 Administrative Feasibility. Long-term institutional management will be associated with this alternative until soil monitoring shows that natural attenuation of the chlorobenzene has occurred. Institutional controls are easily implemented as the MIANG has exclusive use of the property.

4.3.3.4.3 Availability of Services and materials. Construction materials, equipment suppliers, and contracting services are regionally available for treatment, on-going monitoring, and the five-year reviews.

4.3.3.5 Costs. The costs associated with this alternative are presented in Table 4-3. Assuming a 7 percent discount rate, the 10-year, present-worth cost for this alternative is $620,161 (-30 to +50 percent). Assumptions for the cost estimate are presented in Appendix A-1.

TABLE 4-3
Cost Estimate for Alternative 1-3: Limited Action for Soils and Aboveground Groundwater Treatment
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS				
Institutional Controls (a)	1	lump sum		$15,000
PRE-DESIGN ACTIVITIES				
Work Plan/Sampling Plan (l) (n)	1	lump sum		$7,000
Well Installation (b)	1	lump sum		$1,500
Groundwater Sampling (g)	1	lump sum		$5,000
Soil Sampling (h)	1	lump sum		$10,000
Groundwater Modeling (d)	1	lump sum		$20,000
Bench Scale Testing/Pumping Test	1	lump sum		$17,000
ABOVEGROUND GROUNDWATER TREATMENT (Equipment and Construction Cost) (e)				
Air Stripping and Ion Exchange Packages	1	lump sum	$67,500	$67,500
Mechanical Installation	1	lump sum	$14,600	$14,600
Electrical Installation	1	lump sum	$12,500	$12,500
Building Installation	1	lump sum	$14,600	$14,600
Extraction and Reinjection Well Installation	1	lump sum	$18,000	$18,000
Trenching and Underground Piping	400	ft	$36	$14,400
Mobilization/Demobilization (m)	5% of Equipment and Construction Cost			$7,080
	DIRECT CAPITAL COSTS (DDC)			$224,180
INDIRECT CAPITAL COSTS				
Engineering	6% of DCC			$13,451
Construction Oversight/Technical Support	15% of DCC			$33,627
Permitting	8% of DCC			$17,934
Contingency	20% of DCC			$44,836
	INDIRECT CAPITAL COST			$109,848
	TOTAL CAPITAL COSTS			$334,028
ANNUAL O&M COSTS				
MONITORING				
Groundwater Monitoring (c)	1	yearly		$8,000
GROUNDWATER TREATMENT				
Treatment Costs (k)	1	yearly		$10,000
Influent/Effluent Monitoring (f)	1	yearly		$6,000
Maintenance Costs (j)	1	yearly		$15,000
	TOTAL ANNUAL COSTS			$39,000

TABLE 4-3 (continued)
Cost Estimate for Alternative 1-3: Limited Action for Soils and Aboveground Groundwater Treatment
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
FIVE-YEAR COSTS				
MONITORING				
Soil Monitoring (i)	1	lump sum		$4,500
SITE REVIEW				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,500
Report Preparation	1	lump sum		$1,500
		FIVE YEAR REVIEW COSTS		$10,000
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	10	years (o)		
		TOTAL PRESENT WORTH		$620,161

Assumptions for this cost estimate are located in Appendix A-1

4.3.3.6 Reduction of Toxicity, Mobility, or Volume. The limited action portion of this alternative (for the soil) will not actively reduce the toxicity, mobility, or volume of the impacts. As natural attenuation occurs, there will be a reduction in the toxicity, mobility and volume of soil contaminants. The groundwater treatment portion of this alternative will result in the reduction of mobility, toxicity, and volume of constituents in the groundwater.

4.3.3.7 Compliance with ARARs. Since constituent levels in the soil have been shown to be protective of groundwater, and constituents in the soil samples were not detected at concentrations exceeding the Industrial Direct Contact Values, the soil currently meets ARARs. Treated groundwater will meet the groundwater ARARs because the groundwater treatment system will remove the groundwater contamination.

4.3.4 Alternative 1-4: Aboveground Soil Treatment (Enhanced Volatilization) and Aboveground Groundwater Treatment (Air Stripping and Ion Exchange)

Alternative 1-4 will include enhanced volatilization to treat the organic constituents in the soil, and air stripping and ion exchange systems to treat groundwater. This alternative will include pre-design activities to verify the extent of contamination in the groundwater and soil. Additional pre-design activities will include a pilot test for the enhanced volatilzation system, and a bench scale test for the ion exchange system. A system pump test will also be included in the pre-design activities. Institutional controls will be implemented to prevent future use of groundwater until contamination is reduced to levels that meet ARARs.

Soil containing the chlorobenzene will be excavated and treated using enhanced volatilization. Treated soil will be used to backfill the excavated area. The groundwater treatment in this alternative will be the same as that described for Alternative 1-3. It is anticipated that this alternative will require 10 years to remediate groundwater impacts. In addition, five-year reviews will be completed during remediation efforts to assess the site during the 10 years of remediation. An assessment of Alternative 1-4 follows:

4.3.4.1 Short-Term Effectiveness. Institutional controls will be effective in reducing the likelihood of human exposure to groundwater contamination at the site during remediation activities. Groundwater is currently not used, nor is it expected to be used as a drinking water source. Therefore, groundwater use should not be an issue. Workers will need to follow safety procedures and wear appropriate protective equipment during excavation of soils for this alternative. The groundwater treatment activities should pose no unacceptable health risks to workers or the environment.

4.3.4.2. Long-Term Effectiveness. This alternative will be effective over the long-term in reducing the contamination in soil and groundwater. Once treated, the soil will no longer pose an unacceptable risk to human health. This alternative will meet the RAOs established for soil in Section 2.3 once the treatment is complete. This alternative will also be effective in treating the groundwater and reducing the contamination in the groundwater. This alternative will meet the RAOs established for groundwater in Section 2.3 once treatment is complete.

4.3.4.3 Overall Protection of Human Health and the Environment. This alternative will be effective in the overall protection of human health and the environment. Once the treatment actions have been completed for this alternative, Site 1 soil and groundwater will pose no risk to human health or the environment.

4.3.4.4 Implementability. Technical and administrative feasibility of Alternative 1-4 and the availability of the goods and services needed to implement it are as follows:

4.3.4.4.1 Technical Feasibility. Site activities planned under this alternative are technically feasible and readily implemented.

4.3.4.4.2 Administrative Feasibility. The institutional controls required prior to completion of this alternative are easily implemented as the MIANG has exclusive use of the property.

4.3.4.4.3 Availability of Services and materials. Construction materials, equipment suppliers, and contracting services are regionally available for the treatment system, on-going monitoring, and the five-year reviews.

4.3.4.5 Costs. The costs associated with this alternative are presented in Table 4-4. Assuming a 7 percent discount rate, the 10-year, present-worth cost for this alternative is $780,880 (-30 to +50 percent). Assumptions for the cost estimate are presented in Appendix A-1.

4.3.4.6 Reduction of Toxicity, Mobility, or Volume. The treatment options for both the groundwater and soil will result in the reduction of mobility, toxicity, and volume of impacts.

4.3.4.7 Compliance with ARARs. Once treated, the groundwater will meet the appropriate ARARs. Since constituent levels the soil have been shown to be protective of groundwater, and there were no detections in the soil samples above the Industrial Direct Contact Values, the soil currently meets ARARs.

TABLE 4-4
Cost Estimate for Alternative 1-4: Aboveground Treatment of Soil and Groundwater
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS (DDC)				
Institutional Controls (a)	1	lump sum		$10,000
PRE-DESIGN ACTIVITIES				
Work Plan/Sampling Plan (l) (n)	1	lump sum		$7,000
Well Installation (b)	1	lump sum		$1,500
Groundwater Sampling (g)	1	lump sum		$5,000
Soil Sampling (h)	1	lump sum		$10,000
Groundwater Modeling (d)	1	lump sum		$20,000
SVE Pilot Test Study	1	lump sum		$5,000
Bench Scale Testing/Pumping Test	1	lump sum		$17,000
ENHANCED VOLATILIZATION				
Clear and Grub	0.5	acre	$2,500	$1,250
Excavation of Soils	2800	ton	$6	$16,800
Treatment	2800	ton	$15	$42,000
Backfilling of Soils	2800	ton	$8	$22,400
Reseed	0.5	acre	$2,650	$1,325
ABOVEGROUND GROUNDWATER TREATMENT (Equipment and Construction Cost) (e)				
Air Stripping and Ion Exchange Packages	1	lump sum	$67,500	$67,500
Mechanical Installation	1	lump sum	$14,600	$14,600
Electrical Installation	1	lump sum	$12,500	$12,500
Building Installation	1	lump sum	$14,600	$14,600
Extraction and Injection Well Installation	1	lump sum	$18,000	$18,000
Trenching and Underground Piping	400	ft	$36	$14,400
Mobilization/Demobilization (m)	5% of Equipment and Construction Cost			$11,269
	DIRECT CAPITAL COSTS (DDC)			$312,144
INDIRECT CAPITAL COSTS				
Engineering	6% of DDC			$62,429
Construction Oversight/Technical Support	15% of DCC			$46,822
Permitting	8% of DDC			$24,972
Contingency	20% of DDC			$62,429
	INDIRECT CAPITAL COSTS			$196,651
	TOTAL CAPITAL COSTS			$508,794

TABLE 4-4 (continued)
Cost Estimate for Alternative 1-4: Aboveground Treatment of Soil and Groundwater
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
ANNUAL O&M COSTS				
MONITORING				
Groundwater Monitoring (c)	1	yearly		$8,000
GROUNDWATER TREATMENT				
Treatment Costs (k)	1	yearly		$8,000
Influent/Effluent Monitoring (f)	1	yearly		$6,000
Maintenance Costs (j)	1	yearly		$15,000
TOTAL ANNUAL COSTS				$37,000
FIVE-YEAR COSTS				
MONITORING				
Soil Monitoring (i)	1	lump sum		$4,500
SITE REVIEW				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,500
Report Preparation	1	lump sum		$1,500
FIVE YEAR REVIEW COSTS				$10,000
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	10	years (o)		
TOTAL PRESENT WORTH				$780,880

Assumptions for this cost estimate are located in Appendix A-1

4.3.5 Comparative Analysis of Site 1 Alternatives

Alternative 1-2 is the most appropriate choice for remediation of Site 1. Alternative 1-2 (limited action) will provide overall protection of human health and the environment. This alternative will be the most cost effective remediation of the soil and groundwater contamination at Site 1. Institutional controls will provide protection of human health during the natural attenuation of the soil and groundwater contamination. Once the natural attenuation of contamination has occurred to levels meeting regulatory limits, this alternative will provide overall protection of human health and the environment. As the natural attenuation of contamination occurs, this alternative will meet groundwater and soil RAOs and ARARs.

Alternative 1-3 will include active removal of groundwater contamination and natural attenuation of soil contamination. This alternative will not offer immediate results; removal of the groundwater contamination is expected to take nearly as long as the natural attenuation of the groundwater contamination. This alternative will offer the same protection to human health and the environment, and compliance with ARARs and RAOs as Alternative 1-2, but at nearly six times the cost.

Alternative 1-4 will include active removal of both groundwater and soil contamination. The groundwater treatment in this alternative is the same as Alternative 1-3. As previously indicated, it is expected that the soil treatment alternative will take nearly as long as the natural attenuation of groundwater contamination. The enhanced volatilization of soils will remove the non-cancer risk and thus be protective of human health. However, the soil contaminants are present in the subsurface soil and will not be exposed unless construction activities are undertaken. The use of respirators during construction will address potential risks to workers. Active remediation of soil and groundwater will cost ten times more than a natural attenuation alternative (Alternative 1-2). The cost of active remediation of groundwater and soil is not justified for the relatively low levels of contamination at Site 1.

Alternative 1-1 includes no action to monitor or treat Site 1 impacts. This alternative will not protect human health or the environment. This alternative will not meet all ARARs or RAOs. Alternative 1-1 is not an acceptable alternative for Site 1.

4.4 ANALYSIS OF ALTERNATIVES FOR SITE 3

Remedial Action alternatives for Site 3 are presented below. Table 4-5 summarizes the results of the analysis for the Site 3 alternatives.

4.4.1 Alternative 3-1: No Action

The no action alternative serves as a baseline for comparison with other remedial alternatives. Under this alternatives, no remedial actions will be performed at Site 3 to contain or reduce the constituents detected in soil or groundwater. An assessment of Alternative 3-1 follows:

4.4.1.1 Short-Term Effectiveness. The soil at Site 3 has been shown to be protective of groundwater since none of the constituents detected in the soil samples were detected in groundwater samples at levels exceeding of Industrial Drinking Water Values in the most recent (1993) groundwater sampling. In addition, none of the constituents in the soil samples were detected at concentrations exceeding Industrial Direct Contact Values. None of the detections in the most recent (1993) groundwater samples were in excess of Industrial Drinking Water Values. Therefore, the no action alternative will be effective in the short-term in protecting human health and the environment.

4.4.1.2 Long-Term Effectiveness. Since this site currently poses no threat to human health or the environment, the no action alternative will be effective in the long-term and will meet the RAOs established for groundwater and soil.

4.4.1.3 Overall Protection of Human Health and the Environment. Based on the data presented in the RI Report, there are currently no human health or environmental issues at this site. Therefore, the no action alternative will be effective in the overall protection of human health and the environment.

TABLE 4-5
Comparative Analysis of Remedial Alternatives for Site 3
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Estimated Cost[a]	Overall Protection of Human Health and the Environment	Implementability	Reduction of Toxicity, Mobility, and Volume	Compliance with ARARs and RAOs
3-1 No Action	$0	Based on the RI Report data, there is currently no human health or environmental concerns. Therefore, this action will be effective in the overall protection of human health and the environment.	No action to implement.	No active reduction in MTV[b] in soil or groundwater. Based on RI Report data there is currently no need to reduce MTV for groundwater or soil impacts.	Will meet ARARs and RAOs for both groundwater and soil.
3-2 Limited Action (Natural Attenuation/Monitoring)	$29,593 to $63,414	Based on the RI Report data, there is currently no human health or environmental concerns. Therefore, this action will be effective in the overall protection of human health and the environment. This alternative will provide three additional rounds of confirmatory groundwater sampling to support current site data.	All activities planned under this alternative are easily implemented. Administrative management, additional monitoring, and a 5-year review will be required.	No active reduction in MTV. Based on RI Report data there is currently no need to reduce MTV for groundwater or soil impacts.	Will meet ARARs and RAOs for both groundwater and soil.

Notes:
(a) Present worth cost is calculated based on a 7 percent discount rate over the duration of the alternative.
(b) M=mobility, T=toxicity, V=volume

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4.4.1.4 Implementability. Technical and administrative feasibility of Alternative 3-1 and the availability of the goods and services needed to implement it are as follows:

4.4.1.4.1 Technical Feasibility. There are no actions to implement under this alternative.

4.4.1.4.2 Administrative Feasibility. There are no actions to implement under this alternative.

4.4.1.4.3 Availability of Services and Materials. No construction materials or contracting services will be required to implement this alternative.

4.4.1.5 Cost. There is no cost associated with this alternative.

4.4.1.6 Reduction of Toxicity, Mobility, or Volume. The no action alternative will not result in the reduction of toxicity, mobility, or volume. Based on the information presented in the RI Report, there is currently no need to reduce the toxicity, mobility, or volume of the constituents detected in the soil and groundwater at this site because there are currently no concerns associated with the detected levels.

4.4.1.7 Compliance with ARARs. Since the soil has been shown to be protective of groundwater and there were no constituents detected at concentrations exceeding the Industrial Direct Contact Values, the soil currently meets ARARs. The groundwater meets ARARs since the most recent round of groundwater sampling (1993) detected no constituents at concentrations exceeding Industrial Drinking Water Values.

4.4.2 Alternative 3-2: Limited Action (Natural Attenuation and Monitoring)

Based on the field data presented in the RI Report, this site currently poses no risk to human health or the environment. Under the limited action alternative, additional monitoring will be completed to support and confirm the information in the RI Report. This alternative will include

three additional rounds of groundwater sampling to be completed in 5 years. This alternative will also include institutional controls to prevent groundwater use until the three rounds of sampling are complete. A five-year review will then be completed to evaluate the site. An assessment of Alternative 3-2 follows:

4.4.2.1 Short-Term Effectiveness. The limited action alternative will be effective in the short-term in protecting human health and the environment. The soil at Site 3 has been shown to be protective of groundwater because there were no constituents detected in the soil samples at concentrations exceeding Industrial Direct Contact Values. In addition, none of the constituents detected in the 1993 groundwater samples were at concentrations exceeding Industrial Drinking Water Values. The institutional controls will ensure that groundwater is not used until the monitoring in this alternative is complete.

4.4.2.2 Long-Term Effectiveness. Since this site currently poses no threat to human health or the environment, the limited action alternative will be effective in the long-term and will meet the RAOs established for groundwater and soil. Three additional rounds of confirmatory groundwater sampling will be completed to support the 1993 results and confirm that there is no groundwater contamination at this site.

4.4.2.3 Overall Protection of Human Health and the Environment. Based on the data presented in the RI Report, there are currently no human health or environmental issues at this site. Therefore, the limited action alternative will be effective in the overall protection of human health and the environment. Institutional controls will ensure that groundwater is not used until the additional sampling is completed to support the 1993 RI groundwater sampling.

4.4.2.4 Implementability. Technical and administrative feasibility of Alternative 3-2 and the availability of the goods and services needed to implement it are as follows:

4.4.2.4.1 Technical Feasibility. All site activities planned under this alternative are technically feasible. The groundwater monitoring and the five-year review required for this alternative are easily implemented.

4.4.2.4.2 Administrative Feasibility. Administrative management is associated with the alternative until monitoring activities are completed.

4.4.2.4.3 Availability of Services and Materials. No construction materials are needed for this alternative. Contractor services are readily available to complete the monitoring and the five-year review.

4.4.2.5 Cost. The costs associated with this alternative are presented in Table 4-6. Assuming a 7 percent discount rate, the five-year, present-worth cost for this alternative is $42,276 (-30 to +50 percent). Assumptions for the cost estimate are presented in Appendix A-2.

4.4.2.6 Reduction of Toxicity, Mobility, or Volume. The limited action alternative will not result in active reduction of toxicity, mobility, or volume. Based on the information presented in the RI Report, there is currently no need to reduce the toxicity, mobility, or volume of the constituents detected in the soil and groundwater at this site because there is currently no concerns associated with the detected levels.

4.4.2.7 Compliance with ARARs. Since the soil has been shown to be protective of groundwater and there were no constituents detected at levels exceeding Industrial Direct Contact Values, the soil meets ARARs. The groundwater meets ARARs since the most recent round of groundwater sampling (1993) detected no constituents at levels exceeding the Industrial Drinking Water Values.

TABLE 4-6
Cost Estimate for Alternative 3-2: Limited Action
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS				
Institutional Controls (a)	1	lump sum		$10,000
PRE-DESIGN ACTIVITIES				
Work Plan/Sampling Plan (b)	1	lump sum		$4,000
INDIRECT CAPITAL COSTS				
Contingency (a)	1	lump sum		$5,000
	TOTAL CAPITAL COSTS			$19,000
MONITORING COSTS				
MONITORING				
Groundwater Monitoring (c)	1	lump sum		$8,000
	TOTAL ANNUAL COSTS			$8,000
FIVE-YEAR COSTS				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,000
Report Preparation	1	lump sum		$1,500
	FIVE YEAR REVIEW COSTS			$5,000
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	5	years		
	TOTAL PRESENT WORTH			$42,276

Assumptions for this cost estimate are located in Appendix A-2.

4.4.3 Comparative Analysis of Site 3 Alternatives

Alternative 3-1 is the most appropriate choice for Site 3. The no action alternative (Alternative 3-1) will be protective of human health and the environment for Site 3. This alternative will meet RAOs and ARARs established for groundwater and soil. Based on the information presented in the RI Report, Site 3 currently poses no human health or environmental concerns. Levels of constituents detected in the soil samples did not exceed the Industrial Direct Contact Values. The soil has been shown to be protective of groundwater since none of the constituents detected in the soil were detected at concentrations exceeding Industrial Drinking Water Values during the most recent groundwater sampling. There have been a total of four rounds (1987, 1988, 1991, and 1993) of groundwater sampling. During the first three rounds of sampling, manganese was the only constituent detected at concentrations in excess of regulatory limits. During the 1993 sampling, there were no constituents detected in excess of Industrial Drinking Water Values.

The limited action alternative (Alternative 3-2) will provide additional groundwater monitoring for Site 3. This alternative, like Alternative 3-1, will be protective of human health and the environment. Alternative 3-2 will meet RAOs and ARARs established for groundwater and soil. Based on the information presented in the RI Report, Site 3 currently poses no human health or environmental concerns. There are sufficient sampling data to support Site 3. Therefore, additional sampling is not necessary.

4.5 Individual Analysis of Alternatives for Site 5

Remedial Action alternatives for Site 5 are presented below. Table 4-7 summarizes the results of the analysis for the Site 5 alternatives.

4.5.1 Alternative 5-1: No Action

The no action alternative serves as a baseline for comparison with other remedial alternatives. Under this alternative, no remedial actions will be performed at Site 5 to contain or reduce the constituents detected in the groundwater and soil. An assessment of Alternative 5-1 follows:

4.5.1.1 Short-Term Effectiveness. This alternative will not be effective in the short-term in preventing human exposure to the groundwater contamination at the site or in determining the extent of the benzene contamination.

4.5.1.2 Long-Term Effectiveness. This alternative will be ineffective over the long-term. The no action alternative will not meet the groundwater RAOs presented in Section 2.3. There may be natural attenuation of the benzene in the groundwater, but this alternative will not provide any means to monitor or assess the attenuation. Although groundwater is not currently used at the Alpena CRTC and future use is not anticipated, this alternative offers no institutional controls to guarantee that groundwater is not used in the future.

4.5.1.3 Overall Protection of Human Health and the Environment. Under this alternative, no action will be taken to reduce the potential for human exposure or to protect the environment.

4.5.1.4 Implementability. Technical and administrative feasibility of Alternative 5-1 and the availability of the goods and services needed to implement it are as follows:

4.5.1.4.1 Technical Feasibility. There are no actions to implement under this alternative.

TABLE 4-7
Comparative Analysis of Remedial Alternatives for Site 5
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Estimated Cost[a]	Overall Protection of Human Health and the Environment	Implementability	Reduction of Toxicity, Mobility, and Volume	Compliance with ARARs and RAOs
5-1 No Action	$0	No actions will be taken to protect human health or the environment.	No actions to implement.	No reduction in MTV[b] for groundwater contaminants. Based on current information, there is no need to reduce MTV for constituents detected in the soil.	Will not be able to prove compliance with ARARs or RAOs. Will meet soil ARARs and RAOs.
5-2 Limited Action (Natural Attenuation/Monitoring/ Restrictions)	$65,384 to $140,109	Once natural attenuation of groundwater contaminant levels occurs, this alternative will provide overall protection of human health and the environment. Deed restrictions will protect human health during the attenuation of impacts.	All activities planned under this alternative are easily implemented. Administrative management, monitoring, and 5-year reviews will be required.	No active reduction in MTV. As constituent levels naturally attenuate there will be a reduction in MTV for groundwater constituents. Based on current information, there is no need to reduce MTV for constituents detected in the soil.	As groundwater contaminant levels naturally attenuate, the groundwater will meet ARARs and RAOs. Will meet soil ARARs and RAOs.
5-3 In-situ Groundwater Treatment (Air-sparging)	$191,099 to $409,497	Once treatment occurs, this alternative will provide protection of human health and the environment. Deed restrictions will protect human health during remediation activities.	All activities planned under this alternative are readily implemented. Long-term management and monitoring, and 5-year reviews will be required. Pilot scale testing will be required.	Groundwater treatment will result in active reduction of MTV in groundwater. Based on current information, there is no need to reduce MTV for constituents detected in the soil.	Once treated, the groundwater will meet ARARs and RAOs. Will meet soil ARARs and RAOs.

TABLE 4-7 (Continued)
Comparative Analysis of Remedial Alternatives for Site 5
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Estimated Cost[(a)]	Overall Protection of Human Health and the Environment	Implementability	Reduction of Toxicity, Mobility, and Volume	Compliance with ARARs and RAOs
5-4					
Aboveground Groundwater Treatment (Air Stripping)	$312,897 to $670,996	Once treatment occurs, this alternative will provide protection of human health and the environment. Deed restrictions will protect human health during remediation activities.	All activities planned under this alternative are readily implemented. Long-term management, monitoring, and 5-year reviews will be required. System pumping test will be required.	Groundwater treatment will result in active reduction of MTV in groundwater. Based on current information, there is no need to reduce MTV for constituents detected in the soil.	Once treated, the groundwater will meet ARARs and RAOs. Will meet soil ARARs and RAOs.

Notes:
(a) Present worth cost is calculated based on a 7 percent discount rate over the duration of the alternative.
(b) M=mobility, T=toxicity, V=volume

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4.5.1.4.2 Administrative Feasibility. There are no actions to implement under this alternative.

4.5.1.4.3 Availability of Services and Materials. No construction materials or contracting services will be required to implement this alternative.

4.5.1.5 Cost. There is no cost associated with this alternative.

4.5.1.6 Reduction of Toxicity, Mobility, or Volume. The no action alternative will not result in a reduction of toxicity, mobility, or volume of contaminants. There may be natural attenuation of groundwater contaminant levels, but the no action alternative will not provide any means for monitoring the attenuation. Based on current information, there is no need to reduce the mobility, toxicity, or volume of the constituents detected in the soil.

4.5.1.7 Compliance with ARARs. The no action alternative will not meet groundwater ARARs for this site. Since the soil has been shown to be protective of groundwater and constituents were not detected at levels exceeding the Industrial Direct Contact Values, the soil currently meets ARARs.

4.5.2 Alternative 5-2: Limited Action (Natural Attenuation, Monitoring, and Restrictions) Under the limited action alternative, the groundwater contaminants will not be contained or treated, but rather monitored as they naturally attenuate. Based on the RI Report data, Site 5 soil has been shown to be protective of groundwater. In addition, the soil at Site 5 does not pose a human health risk. Therefore, the Site 5 soils do not require remediation. Initially, this alternative will include pre-design activities to verify the extent of the groundwater contamination. Institutional controls will be used to prevent the use of the groundwater until the contamination is detected in concentrations below cleanup levels. Monitoring of groundwater will track the natural attenuation of the contaminants. It is expected that this alternative will require 10 years for the natural attenuation of the groundwater contaminants to levels below regulatory limits.

Five-year reviews will be completed during the 10 years. An assessment of Alternative 5-2 follows:

4.5.2.1 Short-Term Effectiveness. Institutional controls will be effective in reducing the likelihood of human exposure to groundwater contamination at the site during remediation activities. Groundwater is not currently used and is not planned for future use as a drinking source; therefore, groundwater use should not be an issue. Based on the information presented in the RI Report, there are currently no human health or environmental concerns associated with the soils at this site.

4.5.2.2 Long-Term Effectiveness. This alternative will be effective over the long-term for addressing the benzene in the groundwater, if it can be determined that it is not migrating away from Site 5. The likely source of the benzene is due to past operational practices at the site. Since these operational practices are no longer used, it is inferred that there is no longer a source of benzene. Groundwater results from 1987 to 1993 for monitoring well SF5MW1 show a general decline in the levels of benzene in the groundwater. Benzene is readily biodegradable, thus it is expected that the benzene is naturally attenuating.

The limited action alternative will meet the groundwater RAOs presented in Section 2.3 if pre-design sampling shows that the benzene is attenuating. In addition, this alternative will meet the RAOs established for the soil.

4.5.2.3 Overall Protection of Human Health and the Environment. Once the natural attenuation of the benzene is complete, there will be no human health or environmental concerns at this site.

4.5.2.4 Implementability. Technical and administrative feasibility of Alternative 5-2 and the availability of the goods and services needed to implement it are as follows:

4.5.2.4.1 Technical Feasibility. All site activities planned under this alternative are technically feasible. The groundwater monitoring and the five-year reviews required for this alternative are easily implemented.

4.5.2.4.2 Administrative Feasibility. Administration management is associated with the alternative while the attenuation is being monitored. Institutional controls are easily implemented as the MIANG has exclusive use of the property.

4.5.2.4.3 Availability of Services and Materials. Materials are readily available for the installation of additional monitoring wells. Contractor services are readily available to complete additional sampling activities, monitoring, and the five-year reviews.

4.5.2.5 Cost. The costs associated with this alternative are presented in Table 4-8 Assuming a 7 percent discount rate, the 10-year, present-worth cost for this alternative is $93,406 (-30 to +50 percent). Assumptions for the cost estimate are presented in Appendix A-3.

4.5.2.6 Reduction of Toxicity, Mobility, or Volume. The limited action alternative will not actively reduce the toxicity, mobility, or volume of the groundwater contaminants in the short-term. As the natural attenuation occurs, there will be a reduction in the toxicity, mobility, and volume of the contaminants. Groundwater sampling will allow for the tracking of the constituents in the groundwater as the natural attenuation process occurs. Based on current information, there is no need to reduce toxicity, mobility, or volume of the constituents detected in the soil.

4.5.2.7 Compliance with ARARs. This alternative will meet groundwater ARARs when constituents in the groundwater have attenuated by natural processes to appropriate levels. Since the soil has been shown to be protective of groundwater, and there were no constituents detected at levels exceeding Industrial Direct Contact Values, the soil currently meets ARARs.

TABLE 4-8
Cost Estimate for Alternative 5-2: Limited Action
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS (DDC)				
Institutional Controls (a)	1	lump sum		$10,000
PRE-DESIGN ACTIVITIES				
Work Plans/Sampling Plans (j)	1	lump sum		$4,000
Well Installation (b)	1	lump sum		$3,500
Groundwater Sampling (g)	1	lump sum		$8,000
INDIRECT CAPITAL COSTS				
Contingency (a)	1	lump sum		$5,000
	TOTAL CAPITAL COSTS			$30,500
ANNUAL MONITORING/O&M COSTS				
MONITORING				
Groundwater Monitoring (c)	1	yearly		$8,000
	TOTAL ANNUAL COSTS			$8,000
FIVE-YEAR COSTS				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,500
Report Preparation	1	lump sum		$1,500
	FIVE YEAR REVIEW COSTS			$5,500
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	10	years (o)		
	TOTAL PRESENT WORTH			$93,406

Assumptions for this cost estimate are located in Appendix A-3.

4.5.3 Alternative 5-3: In-situ Groundwater Treatment (Air-Sparging)

Alternative 5-3 will include treatment of the groundwater, with no treatment action for the soil. Based on the RI Report data, Site 5 soil has been shown to be protective of groundwater since none of the constituents detected in the soil samples were detected in the groundwater at concentrations exceeding Industrial Drinking Water Values. In addition, the soil at Site 5 does not pose a human health risk. Therefore, the Site 5 soils do not require remediation.

This alternative includes in-situ treatment of the hydrocarbons in groundwater using naturally occurring microbes. Air-sparging uses air to provide the oxygen necessary for bacteria and other hydrocarbon-destroying microbes to reproduce. The soil temperatures and pH at Site 5 are within the ranges required to maintain such populations. Shallow wells will be placed in the contaminated aquifer. A small blower or compressor will provide the air. The air is injected at an rate optimal for microbial use, while not high enough to cause active volatilization of the benzene. Groundwater monitoring will assess the effectiveness of the bio-degradation. Institutional controls will be used to prevent the use of groundwater until the contaminants are detected at concentrations below regulatory limits. It is expected that this alternative will require 10 years to remediate the site. In addition, this alternative will include five-year review of the site following remediation. Pre-design activities for this alternative include sampling activities to verify the extent of the groundwater contamination. Additional pre-design activities will include a pilot test for the air-sparging system. An assessment of Alternative 5-3 follows:

4.5.3.1 Short-Term Effectiveness. Institutional controls will be effective in reducing the likelihood of human exposure to groundwater contamination at the site during remediation activities. Groundwater is currently not used and is not planned for future use as a drinking water source; therefore, groundwater use should not be an issue. Based on the information presented in the RI Report, there are currently no human health or environmental concerns associated with the soil at this site.

4.5.3.2. Long-Term Effectiveness. This alternative will be effective over the long-term in treating contamination at the site and preventing risks to human health and the environment.

4.5.3.3 Overall Protection of Human Health and the Environment. The active bio-degradation of the organic groundwater contaminants will provide overall protection of human health and the environment.

4.5.3.4 Implementability. Technical and administrative feasibility of Alternative 5-3 and the availability of the goods and services needed to implement it are as follows:

4.5.3.4.1 Technical Feasibility. All site activities planned under this alternative are technically feasible. The groundwater monitoring and the five-year reviews required for this alternative are easily implemented.

4.5.3.4.2 Administrative Feasibility. Institutional controls are easily implemented as the MIANG has exclusive use of the property.

4.5.3.4.3 Availability of Services and Materials. Materials are readily available for the installation of the air-sparge system and associated equipment. Contractor services are readily available to complete the sampling, the installation and O&M of the air-sparge system, the monitoring, and the five-year review.

4.5.3.5 Cost. The costs associated with this alternative are presented in Table 4-9. Assuming a 7 percent discount rate, the ten-year, present-worth cost for this alternative is $272,998 (-30 to +50 percent). Assumptions for the cost estimate are presented in Appendix A-3.

4.5.3.6 Reduction of Toxicity, Mobility, or Volume. Air-sparging will result in the reduction of toxicity, mobility, or volume of organic contaminants in the groundwater. Based on current information, there is no need to reduce the toxicity, mobility, or volume of constituents detected in the soil.

TABLE 4-9
Cost Estimate for Alternative 5-3: In-situ Groundwater Treatment
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS				
Institutional Controls (a)	1	lump sum		$10,000
PRE-DESIGN ACTIVITIES				
Work Plans/Sampling Plans (j)	1	lump sum		$4,000
Well Installation (b)	1	lump sum		$3,500
Groundwater Sampling (g)	1	lump sum		$8,000
Pilot Scale Testing	1	lump sum		$10,000
BIO-SPARGING TREATMENT (Equipment and Construction Costs Included) (e)				
Sparge Blower Package	1	lump sum	$5,000	$5,000
Mechanical Installation	1	lump sum	$11,300	$11,300
Electrical Installation	1	lump sum	$3,300	$3,300
Building Installation	1	lump sum	$1,350	$1,350
Sparge Well Installation (n)	30	wells	$600	$18,000
Trenching and Underground Piping	900	ft	$11	$9,900
Mobilization/Demobilization (k)	5% of Equipment and Construction Cost			$2,443
	DIRECT CAPITAL COSTS (DCC)			$86,793
INDIRECT CAPITAL COSTS				
Engineering		6% of DCC		$5,208
Construction Oversight/Technical Support		15% of DCC		$13,019
Permitting		8% of DCC		$6,943
Contingency		20% of DCC		$17,359
	INDIRECT CAPITAL COSTS			$42,528
	TOTAL CAPITAL COSTS			$129,321
ANNUAL O&M COSTS				
MONITORING				
Groundwater Monitoring (c)	1	yearly		$8,000
GROUNDWATER TREATMENT				
Treatment Costs (i)	1	yearly		$1,500
Maintenance Costs (h)	1	yearly		$10,000
	TOTAL ANNUAL COSTS			$19,500

TABLE 4-9 (continued)
Cost Estimate for Alternative 5-3: In-situ Groundwater Treatment
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
FIVE-YEAR COSTS				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,500
Report Preparation	1	lump sum		$1,500
FIVE YEAR REVIEW COSTS				$5,500
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	10	years (o)		
TOTAL PRESENT WORTH				$272,998

Assumptions for this cost estimate are located in Appendix A-3.

4.5.3.7 Compliance with ARARs. As the organic constituents are bio-degraded, this alternative will meet ARARs for the groundwater. Since the soil has been shown to be protective of groundwater and there were no constituents detected in soil samples at levels exceeding Industrial Direct Contact Values, the soil currently meets ARARs.

4.5.4 Alternative 5-4: Aboveground Groundwater Treatment (Air Stripping)

Alternative 5-4 includes treatment of the groundwater, but no treatment action for the soil. Based on the RI Report data, Site 5 soil has been shown to be protective of groundwater since none of the constituents detected in the soil samples were detected in the groundwater at levels exceeding Industrial Drinking Water Values. In addition, the soil at Site 5 does not pose a human health risk. Therefore, the Site 5 soils do not require remediation.

Alternative 5-4 uses an air stripper to remove benzene from the groundwater at Site 5. Groundwater will be extracted using groundwater extraction wells. Once extracted, the groundwater will be pumped to an air stripper. Both the influent and effluent of the treatment system are monitored and analyzed regularly. The treated groundwater is then reinjected into the aquifer. Groundwater modeling is required prior to design to determine the exact placement of the extraction wells and the reinjection wells. Additional pre-design activities will include sampling to verify the extent of the contamination and a system pumping test. Based on hydrogeologic information presented in the RI Report and professional experience in designing groundwater extraction systems at sites with similar hydrogeological characteristics, the estimated total groundwater extraction rate is between 5 and 15 gpm. Groundwater will be monitored annually to assess the performance of the air stripping system. Institutional controls will be used to prevent the use of groundwater until impacts are detected at concentrations below ARARs. It is expected that this alternative will require 10 years to remediate contamination to levels below the regulatory limits. During remediation, five-year reviews will be completed. An assessment of Alternative 5-4 follows:

4.5.4.1 Short-Term Effectiveness. Institutional controls will be effective in reducing the likelihood of human exposure to groundwater contamination at the site during remediation

activities. Groundwater is currently not used and is not planned for future use as a drinking water source. Therefore, groundwater use should not be an issue. Based on the information presented in the RI Report, there are currently no human health or environmental concerns associated with the soil at this site.

4.5.4.2. Long-Term Effectiveness. This alternative will be effective over the long-term in treating contamination at the site and preventing risks to human health and the environment.

4.5.4.3 Overall Protection of Human Health and the Environment. Remediation of the organic groundwater contamination by air stripping will provide overall protection of human health and the environment.

4.5.4.4 Implementability. The technical and administrative feasibility of Alternative 5-4 and the availability of the goods and services needed to implement it are as follows:

4.5.4.4.1 Technical Feasibility. All site activities planned under this alternative are technically feasible. The groundwater monitoring and the five-year reviews required for this alternative are easily implemented.

4.5.4.4.2 Administrative Feasibility. Institutional controls are easily implemented as the MIANG has exclusive rights to the property.

4.5.4.4.3 Availability of Services and Materials. Materials are readily available for the installation of the extraction and reinjection wells, the air stripper, and associated equipment. Contractor services are readily available to complete the sampling, installation, and O&M of the air stripping system, the monitoring, and the five-year reviews.

4.5.4.5 Cost. The costs associated with this alternative are presented in Table 4-10. Assuming a 7 percent discount rate, the 10-year, present-worth cost for this alternative is $446,996 (-30 to +50 percent). Assumptions for the cost estimate are presented in Appendix A-3.

TABLE 4-10
Cost Estimate for Alternative 5-4: Aboveground Groundwater Treatment
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS				
Institutional Controls (a)	1	lump sum		$10,000
PRE-DESIGN ACTIVITIES				
Work Plans/Sampling Plans (j) (l)	1	lump sum		$7,000
Well Installation (b)	1	lump sum		$3,500
Groundwater Sampling (g)	1	lump sum		$8,000
Groundwater Modeling (d)	1	lump sum		$20,000
Pumping Testing	1	lump sum		$10,000
AIR STRIPPING TREATMENT (Equipment and Construction Cost) (e)				
Air Stripper Package	1	lump sum	$16,500	$16,500
Mechanical Installation	1	lump sum	$10,100	$10,100
Electrical Installation	1	lump sum	$8,800	$8,800
Building Installation	1	lump sum	$12,000	$12,000
Extraction and Reinjection Well Installation	1	lump sum	$18,000	$18,000
Trenching and Underground Piping	400	ft	$36	$14,400
Mobilization/Demobilization (k)	5% of Equipment and Construction Cost			$3,990
	DIRECT CAPITAL COSTS (DCC)			$142,290
INDIRECT CAPITAL COSTS				
Engineering		6% of DCC		$8,537
Construction Oversight/Technical Support		15% of DCC		$21,344
Permitting		8% of DCC		$11,383
Contingency		20% of DCC		$28,458
	INDIRECT CAPITAL COSTS			$69,722
	TOTAL CAPITAL COSTS			$212,012
ANNUAL MONITORING/O&M COSTS				
MONITORING				
Groundwater Monitoring (c)	1	yearly		$8,000
GROUNDWATER TREATMENT				
Treatment Costs (i)	1	yearly		$7,500
Influent/Effluent Monitoring (f)	1	yearly		$5,000
Maintenance Costs (h)	1	yearly		$12,000
	TOTAL ANNUAL COSTS			$32,500

TABLE 4-10 (continued)
Cost Estimate for Alternative 5-4: Aboveground Groundwater Treatment
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
FIVE-YEAR COSTS				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,500
Report Preparation	1	lump sum		$1,500
		FIVE YEAR REVIEW COSTS		$5,500
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	10	years (o)		
		TOTAL PRESENT WORTH		$446,996

Assumptions for this cost estimate are located in Appendix A-3.

4.5.4.6 Reduction of Toxicity, Mobility, or Volume. Air stripping will result in the reduction of toxicity, mobility, or volume of organic contaminants in the groundwater. Based on current information, there is no need to reduce the toxicity, mobility, or volume of soil constituents detected in the soil.

4.5.4.7 Compliance with ARARs. Following extraction and removal of the organic constituents from the groundwater, this alternative will meet ARARs for groundwater. Since the soil has been shown to be protective of groundwater and there were no constituents detected in soil samples at levels exceeding Industrial Direct Contact Values, the soil currently meets ARARs.

4.5.5 Comparative Analysis of Site 5 Alternatives

The limited action alternative (Alternative 5-2) is considered the alternative of choice. Alternative 5-2 (limited action) will provide overall protection of human health and the environment. This alternative offers the most cost effective remediation of the groundwater contamination at Site 5. The limited action alternative will be protective of human health and the environment. Alternative 5-2 will meet RAOs and ARARs established for groundwater and soil. Historical groundwater sampling has shown a decrease in the benzene groundwater contamination over time. This decrease in benzene concentrations indicates that attenuation is occurring by natural processes at the Site 5. Additional groundwater sampling will provide information to verify the extent of the benzene and monitor the natural attenuation. While the natural attenuation is occurring, institutional controls will prevent human exposure to groundwater impacts. The limited action alternative will provide an equally effective and less expensive option than the other treatment alternatives.

Alternative 5-3 (in-situ groundwater treatment) will be protective of human health and the environment. The alternative will meet the RAOs and ARARs for groundwater and soil. The cost of this alternative is almost three times that of the limited action alternative.

Alternative 5-4 (aboveground groundwater treatment alternative) will be protective of human health and the environment. The alternative will meet RAOs and ARARs established for

groundwater and soil. The aboveground groundwater treatment alternative is equally effective in treating the groundwater contamination as the in-situ groundwater treatment alternative. The cost of this alternative is approximately six times more expensive than the limited action alternative and more than 2 times the cost of an in-situ treatment alternative.

The no action alternative (Alternative 5-1) will protect human health and the environment. This alternative will not meet all ARARs or RAOs and will not be considered an acceptable alternative.

4.6 ANALYSIS OF ALTERNATIVES FOR SITES 6 AND 7

Remedial action alternatives for Sites 6 and 7 are presented below. Table 4-11 summarizes the results of the analysis for the Sites 6 and 7 alternatives.

4.6.1 Alternative 6/7-1: No Action

The no action alternative serves as a baseline for comparison with other remedial alternatives. Under this alternatives, no remedial actions will be performed at Sites 6 and 7 to contain or reduce constituent levels detected in the soil or groundwater. An assessment of Alternative 6/7-1 follows:

4.6.1.1 Short-Term Effectiveness. The soil at Sites 6 and 7 has been shown to be protective of groundwater since none of the COPCs detected in the soil samples were detected in groundwater samples at concentrations exceeding Industrial Drinking Water Values. Additionally, none of the constituents detected in the soil samples were at concentrations exceeding Direct Contract Values. None of the detections in the most recent groundwater samples (1993) were at levels exceeding the Industrial Drinking Water Values. Therefore, the no action alternative is effective in the short-term in protecting human health and the environment.

4.6.1.2 Long-Term Effectiveness. Since this site currently poses no threat to human health or the environment, the no action alternative will be effective in the long-term and will meet the RAOs established for groundwater and soil.

4.6.1.3 Overall Protection of Human Health and the Environment. Based on the data presented in the RI Report, there are currently no human health or environmental issues at this site. Therefore, the no action alternative will be effective in the overall protection of human health and the environment.

TABLE 4-11
Comparative Analysis of Remedial Alternatives for Sites 6 and 7
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Estimated Cost[a]	Overall Protection of Human Health and the Environment	Implementability	Reduction of Toxicity, Mobility, and Volume	Compliance with ARARs
6/7-1					
No Action	$0	Based on the RI Report data, there is currently no human health or environmental concerns. Therefore, this action will be effective in the overall protection of human health and the environment.	No action to implement.	No reduction in MTV[b] in soil or groundwater. Based on RI Report data there is currently no need to reduce MTV for constituents detected in the groundwater and soil.	Will meet ARARs and RAOs for both groundwater and soil.
6/7-2					
Limited Action (Natural Attenuation/Monitoring)	$29,593 to $63,414	Based on the RI Report data, there is currently no human health or environmental concerns. Therefore, this action will be effective in the overall protection of human health and the environment. This alternative will provide three additional rounds of confirmatory groundwater sampling to support current site data.	All activities planned under this alternative are easily implemented. Administrative management, additional monitoring, and a 5-year review will be required.	No active reduction in MTV. Based on RI Report data there is currently no need to reduce MTV for constituents detected in the groundwater and soil.	Will meet ARARs and RAOs for both groundwater and soil.

Notes:
(a) Present worth cost is calculated based on a 7 percent discount rate over the duration of the alternative.
(b) M=mobility, T=toxicity, V=volume

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4.6.1.4 Implementability. Technical and administrative feasibility of Alternative 6/7-1 and the availability of the goods and services needed to implement it are as follows:

4.6.1.4.1 Technical Feasibility. There are no actions to implement under this alternative.

4.6.1.4.2 Administrative Feasibility. There are no actions to implement under this alternative.

4.6.1.4.3 Availability of Services and Materials. No construction materials or contracting services will be required to implement this alternative.

4.6.1.5 Cost. There is no cost associated with this alternative.

4.6.1.6 Reduction of Toxicity, Mobility, or Volume. The no action alternative will not result in the reduction of toxicity, mobility, or volume of constituents. Based on the information presented in the RI Report, there is currently no need to reduce the toxicity, mobility, or volume of the constituents detected in the soil and groundwater at this site because there are currently no concerns associated with the detected levels.

4.6.1.7 Compliance with ARARs. Since the soils have been shown to be protective of groundwater and there were no constituents detected at levels exceeding Industrial Direct Contact Values, the soil currently meets ARARs. The groundwater meets ARARs since the most recent round of groundwater sampling (1993) detected no constituents at levels exceeding Industrial Drinking Water Values.

4.6.2 Alternative 6/7-2: Limited Action

Based on the field data presented in the RI Report, this site currently poses no risk to human health or the environment. Under the limited action alternative, additional monitoring will be completed to support and confirm the information in the RI Report. This alternative includes

three additional rounds of sampling to be completed in a 5 year period. This alternative also includes institutional controls to prevent groundwater use until the three rounds of sampling are complete. A five-year review will then be completed to assess the site. An assessment of Alternative 6/7-2 follows:

4.6.2.1 Short-Term Effectiveness. The soil at Sites 6 and 7 has been shown to be protective of groundwater since none of the COPCs detected in the soil samples were in groundwater samples at levels exceeding Industrial Drinking Water Values. In addition none of the constituents in the soil samples were detected at concentrations exceeding Direct Contract Values. None of the detected concentrations in the most recent groundwater samples (1993) were in excess of Industrial Drinking Water Values. Therefore, the limited action alternative will be effective in the short-term in protecting human health and the environment. The institutional controls will ensure that the groundwater is not used until the monitoring in this alternative is complete.

4.6.2.2 Long-Term Effectiveness. Since this site currently poses no threat to human health or the environment, the limited action alternative will be effective in the long-term and meets the RAOs established for groundwater and soil. Three additional rounds of groundwater sampling will be completed to support the 1993 results and confirm that there is no groundwater contamination at this site.

4.6.2.3 Overall Protection of Human Health and the Environment. Based on the data presented in the RI Report, there are currently no human health or environmental issues at this site. Therefore, the limited action alternative will be effective in the overall protection of human health and the environment. Institutional controls will ensure that groundwater is not used until the additional sampling is completed to support the 1993 sampling results.

4.6.2.4 Implementability. Technical and administrative feasibility of Alternative 6/7-2 and the availability of the goods and services needed to implement it are as follows:

4.6.2.4.1 Technical Feasibility. All site activities planned under this alternative are technically feasible. The groundwater monitoring and the five-year review required for this alternative are easily implemented.

4.6.2.4.2 Administrative Feasibility. Administration management is associated with the alternative while the attenuation is being monitored. Institutional controls are easily implemented as the MIANG has exclusive use of the property.

4.6.2.4.3 Availability of Services and Materials. No construction materials are needed for this alternative. Contractor services are readily available to complete the monitoring and the five-year review.

4.6.2.5 Cost. The costs associated with this alternative are presented in Table 4-12. Assuming a 7 percent discount rate, the five-year, present-worth cost for this alternative is $42,276 (-30 to +50 percent). Assumptions for the cost estimate are presented in Appendix A-4.

4.6.2.6 Reduction of Toxicity, Mobility, or Volume. The limited action alternative will not result in active reduction of toxicity, mobility, or volume of constituents. Based on the information presented in the RI Report, there is currently no need to reduce the toxicity, mobility, or volume of the constituents detected in the soil and groundwater at this site, because there is currently no concerns associated with the detected levels.

4.6.2.7 Compliance with ARARs. Since the soils have been shown to be protective of groundwater and there were no constituents detected at levels exceeding Industrial Direct Contact Values, the soil meets ARARs. The groundwater meets ARARs since the most recent (1993) round of groundwater sampling detected no constituents at levels exceeding the Industrial Drinking Water Values.

TABLE 4-12
Cost Estimate for Alternative 6/7-2: Limited Action
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS				
Institutional Controls (a)	1	lump sum		$10,000
PRE-DESIGN ACTIVITIES				
Work Plan/Sampling Plan (b)	1	lump sum		$4,000
INDIRECT CAPITAL COSTS				
Contingency (a)	1	lump sum		$5,000
	TOTAL CAPITAL COSTS			$19,000
MONITORING COSTS				
MONITORING				
Groundwater Monitoring (c)	1	lump sum		$8,000
	TOTAL ANNUAL COSTS			$8,000
FIVE-YEAR COSTS				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,000
Report Preparation	1	lump sum		$1,500
	FIVE YEAR REVIEW COSTS			$5,000
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	5	years		
	TOTAL PRESENT WORTH			$42,276

Assumptions for this cost estimate are located in Appendix A-4.

4.6.3 Comparative Analysis of Site 6 and 7 Alternatives

Alternative 6/7-2 is considered the alternative of choice for Sites 6 and 7. Alternative 6/7-2 (limited action) will provide overall protection of human health and the environment. The limited action alternative will meet the RAOs and ARARs for soil and groundwater at Sites 6 and 7. The soil has been shown to be protective of groundwater since the COPCs detected in the soil samples were not detected at levels exceeding Industrial Drinking Water Values in groundwater samples from the sites. There have been four rounds of groundwater sampling at the sites. The most recent round of sampling (1993) showed no detections at levels in excess of the Industrial Drinking Water Values. The limited action alternative will continue the groundwater monitoring by completing three additional rounds of sampling to verify that the sites pose no human health or environmental concern.

The no action alternative (Alternative 6/7-1) will meet RAOs and ARARs for Site 6 and 7 groundwater and soil. Even though the site meets the RAOs, only the most recent round of groundwater sampling showed no constituents at levels exceeding the Industrial Drinking Water Values. Due to the historical activities that occurred at these sites, it will be reasonable to complete three additional rounds of sampling.

4.7 ANALYSIS OF ALTERNATIVES FOR SITE 8

Remedial action alternatives for Site 8 are presented below. Table 4-13 summarizes the results of the analysis for the Site 8 alternatives.

4.7.1 Alternative 8-1: No Action

The no action alternative serves as a baseline for comparison with other remedial alternatives. Under this alternatives, no remedial actions will be performed at Site 8. The data presented in the RI Report indicate that the soil at the site does not pose a risk to human health or the environment. In addition, the four rounds of groundwater sampling completed at the site detected no constituents at concentrations in excess of the Industrial Drinking Water Values. An assessment of Alternative 8-1 follows:

4.7.1.1 Short-Term Effectiveness. The soil at Site 8 has been shown to be protective of groundwater since none of the COPCs detected in the soil samples were detected in groundwater at levels exceeding Industrial Drinking Water Values during any of the four rounds of groundwater sampling completed at the site. In addition, none of the constituents detected in the soil samples were at levels exceeding Direct Contract Values. None of the detections in the groundwater samples were in excess of Industrial Drinking Water Values. Therefore, the no action alternative will be effective in the short-term in protecting human health and the environment.

4.7.1.2 Long-Term Effectiveness. Since this site currently poses no threat to human health or the environment, the no action alternative will be effective in the long-term and will meet the RAOs established for groundwater and soil. The four rounds of groundwater sampling detected no constituent at levels exceeding Industrial Drinking Water Values. The four groundwater sampling rounds completed between 1987 and 1993 provide adequate support of the site conditions. Additional sampling is not necessary at this site.

TABLE 4-13
Comparative Analysis of Remedial Alternatives for Site 8
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Estimated Cost[a]	Overall Protection of Human Health and the Environment	Implementability	Reduction of Toxicity, Mobility, and Volume	Compliance with ARARs
8-1 No Action	$0	Based on the RI Report data, there is currently no human health or environmental concerns. Therefore, this action will be effective in the overall protection of human health and the environment.	No action to implement.	No reduction in MTV[b] in soil or groundwater. Based on RI Report data there is currently no need to reduce MTV.	Will meet ARARs and RAOs for groundwater and soil.
8-2 Limited Action (Natural Attenuation/Monitoring)	$22,593 to $48,414	Based on the RI Report data, there is currently no human health or environmental concerns. Therefore, this action will be effective in the overall protection of human health and the environment. This alternative provides three additional rounds of confirmatory sampling to support the current site data.	All activities planned under this alternative are easily implemented. Administrative management, additional monitoring, and a 5-year review will be required.	No active reduction in MTV. Based on RI Report data there is currently no need to reduce MTV.	Will meet ARARs and RAOs for groundwater and soil.

Notes:
(a) Present worth cost is calculated based on a 7 percent discount rate over the duration of the alternative.
(b) M=mobility, T=toxicity, V=volume

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4.7.1.3 Overall Protection of Human Health and the Environment. Based on the data presented in the RI Report, there are currently no human health or environmental issues at this site. Therefore, the no action alternative will be effective in the overall protection of human health and the environment.

4.7.1.4 Implementability. Technical and administrative feasibility of Alternative 8-1 and the availability of the goods and services needed to implement it are as follows:

4.7.1.4.1 Technical Feasibility. There are no actions to implement under this alternative.

4.7.1.4.2 Administrative Feasibility. There are no actions to implement under this alternative.

4.7.1.4.3 Availability of Services and Materials. No construction materials or contracting services will be required to implement this alternative.

4.7.1.5 Cost. There is no cost associated with this alternative.

4.7.1.6 Reduction of Toxicity, Mobility, or Volume. The no action alternative will not result in the reduction of toxicity, mobility, or volume of constituents. Based on the information presented in the RI Report, there is currently no need to reduce the toxicity, mobility, or volume of the constituents detected in the soil and groundwater at this site, because there are currently no concerns associated with the detected levels.

4.7.1.7 Compliance with ARARs. Since the soil has been shown to be protective of groundwater and there were no constituents detected at levels exceeding Industrial Direct Contact Values, the soil currently meets ARARs. The groundwater meets ARARs since all four rounds of groundwater sampling indicated that constituent levels are not in excess of Industrial Drinking Water Values.

4.7.2 Alternative 8-2: Limited Action

Based on the field data presented in the RI Report, this site currently poses no risk to human health or the environment. Under the limited action alternative, additional monitoring will be completed to support and confirm the information in the RI Report. The limited action will include three additional rounds of sampling for current wells over a five-year period. A five-year review will be completed after the sampling. An assessment of Alternative 8-2 follows:

4.7.2.1 Short-Term Effectiveness. The soil at Site 8 has been shown to be protective of groundwater since none of the COPCs detected in the soil samples were detected in the groundwater samples at levels exceeding Industrial Drinking Water Values. In addition none of the constituents detected in the soil samples were detected at levels exceeding of Direct Contract Values. None of the detections in the groundwater samples were at levels exceeding Industrial Drinking Water Values during any of the four rounds of sampling. Therefore, the limited alternative is effective in the short-term in protecting human health and the environment.

4.7.2.2 Long-Term Effectiveness. Since this site currently poses no threat to human health or the environment, the limited action will be effective in the long-term and will meet the RAOs established for groundwater and soil. The additional sampling completed in this limited action alternative will provide additional data to support the conclusion that the site is not posing human health or environmental concerns.

4.7.2.3 Overall Protection of Human Health and the Environment. Based on the data presented in the RI Report, there are currently no human health or environmental issues at this site. Therefore, the limited action alternative will be effective in the overall protection of human health and the environment.

4.7.2.4 Implementability. The technical and administrative feasibility of Alternative 8-2 and the availability of the goods and services needed to implement it are as follows:

4.7.2.4.1 Technical Feasibility. All site activities planned under this alternative are technically feasible. The groundwater monitoring and a five-year review required for this alternative are easily implemented.

4.7.2.4.2 Administrative Feasibility. Administrative management is associated with the alternative until monitoring activities are completed.

4.7.2.4.3 Availability of Services and Materials. No construction materials are needed for this alternative. Contractor services are readily available to complete the monitoring and the five-year review.

4.7.2.5 Cost. The costs associated with this alternative are presented in Table 4-14. Assuming a 7 percent discount rate, the five-year, present-worth cost for this alternative is $32,276 (-30 to +50 percent). Assumptions for this cost estimate are presented in Appendix A-5.

4.7.2.6 Reduction of Toxicity, Mobility, or Volume. The limited action alternative will not result in active reduction of toxicity, mobility, or volume of site constituents. Based on the information presented in the RI Report, there is currently no need to reduce the toxicity, mobility, or volume of the constituents detected in the soil and groundwater at this site, because there is currently no concerns associated with the detected levels.

4.7.2.7 Compliance with ARARs. The soil currently meets ARARs because the soil has been shown to be protective of groundwater, and because the constituents in the soil were not detected at levels exceeding Industrial Direct Contact Values. The groundwater also currently meets ARARs since all four rounds of groundwater sampling detected no constituents at levels exceeding Industrial Drinking Water Values.

TABLE 4-14
Cost Estimate for Alternative 8-2: Limited Action
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS				
PRE-DESIGN ACTIVITIES				
Work Plan/Sampling Plan (b)	1	lump sum		$4,000
INDIRECT CAPITAL COSTS				
Contingency (a)	1	lump sum		$5,000
	TOTAL CAPITAL COSTS			$9,000
MONITORING COSTS				
MONITORING				
Groundwater Monitoring (c)	1	lump sum		$8,000
	TOTAL ANNUAL COSTS			$8,000
FIVE-YEAR COSTS				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,000
Report Preparation	1	lump sum		$1,500
	FIVE YEAR REVIEW COSTS			$5,000
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	5	years		
	TOTAL PRESENT WORTH			$32,276

Assumptions for this cost estimate are located in Appendix A-5.

4.7.3 Comparative Analysis of Site 8 Alternatives

Alternative 8-1 is considered the alternative of choice for Site 8. The no action alternative (Alternative 8-1) will be protective of human health and the environment. The alternative will meet RAOs and ARARs established for groundwater and soil. Based on the information presented in the RI Report, Site 8 currently poses no human health or environmental concerns. The constituents in the soil samples were detected at levels that did not exceed Industrial Direct Contact Values, and the soil has been shown to be protective of groundwater. In addition, the four rounds of groundwater sampling detected no constituents in the groundwater at levels exceeding Industrial Drinking Water Values.

The limited action alternative (Alternative 8-2) will provide additional groundwater sampling. This alternative, like Alternative 8-1, will be protective of human health and the environment. Alternative 8-2 will meet all RAOs and ARARs for groundwater and soil. Based on the information presented in the RI Report, Site 8 currently poses no human health or environmental concerns. There are sufficient sampling data to support Site 8, and additional sampling should not be necessary.

4.8 ANALYSIS OF ALTERNATIVES FOR SITE 9

Remedial action alternatives for Site 9 soil and groundwater are presented below. Table 4-15 summarizes the results of the analysis for the Site 9 alternatives.

4.8.1 Alternative 9-1: No Action

The no action alternative serves as a baseline for comparison with other remedial alternatives. Under this alternative, no remedial actions will be performed at Site 9 to contain or reduce the levels of the constituents detected in the soil and groundwater. An assessment of Alternative 9-1 follows:

4.8.1.1 Short-Term Effectiveness. This alternative will be ineffective in the short-term in preventing human exposure to contaminants at the site.

4.8.1.2 Long-Term Effectiveness. This alternative will be ineffective over the long-term. The no action alternative will not meet the groundwater RAOs presented in Section 2.3. There will be natural attenuation of the organic constituents in the groundwater, but this alternative will not provide a mechanism to monitor the attenuation process. Although groundwater is not currently used, nor is its future use anticipated at the Alpena CRTC, this alternative will offer no institutional controls to guarantee that groundwater will not be used in the future at this site.

4.8.1.3 Overall Protection of Human Health and the Environment. Under this alternative, no action is taken to reduce the potential for human exposure or protect the environment.

4.8.1.4 Implementability. Technical and administrative feasibility of Alternative 9-1 and the availability of the goods and services needed to implement it are as follows:

4.8.1.4.1 Technical Feasibility. There are no actions to implement under this alternative.

TABLE 4-15
Comparative Analysis of Remedial Alternatives for Site 9
Alpena Combat Readiness Training Center
Alpena, Michigan

Alternative	Estimated Cost[a]	Overall Protection of Human Health and the Environment	Implementability	Reduction of Toxicity, Mobility, and Volume	Compliance with ARARs and RAOs
9-1 No Action	$0	No actions will be taken to protect human health or the environment.	No actions to implement.	No reduction in MTV[b] in groundwater. Based on current information, there is no need to reduce MTV of constituents detected in the soil.	Will not meet groundwater ARARs or groundwater RAOs Will meet soil ARARs but not soil RAOs.
9-2 Limited Action (Natural Attenuation/Monitoring/ Restrictions)	$56,477 to $121,023	Once natural attenuation of groundwater constituent levels occurs, this alternative will provide overall protection of human health and the environment. Deed restrictions will protect human health during the attenuation of impacts.	All activities planned under this alternative are easily implemented. Long-term management, monitoring, and 5-year reviews will be required.	No active reduction in MTV. As constituent levels naturally attenuate there will be reduction in TV. Monitoring will provide information for assessment of reduction in TV. Based on current information, there is no need to reduce MTV of constituents detected in the soil.	As groundwater constituent levels naturally attenuate, the groundwater will meet ARARs and RAOs. will meet soil ARARs and RAOs.
9-3 Aboveground Groundwater Treatment (Air Stripping/Ion Exchange)	$506,639 to $1,085,636	Once treatment occurs, this alternative will provide protection of human health and the environment. Deed restrictions will protect human health during remediation activities.	All activities planned under this alternative are readily implemented. Long-term management, monitoring, and 5-year reviews will be required.	Groundwater treatment will result in active reduction of MTV in groundwater. Based on current information, there is no need to reduce MTV of constituents detected in the soil.	Once treated, the groundwater will meet ARARs and RAOs. Will meet soil ARARs and RAOs.

Notes:
(a) Present worth cost is calculated based on a 7 percent discount rate over the duration of the alternative.
(b) M=mobility, T=toxicity, V=volume

4.8.1.4.2 Administrative Feasibility. There are no actions to implement under this alternative.

4.8.1.4.3 Availability of Services and Materials. No construction materials or contracting services will be required to implement this alternative.

4.8.1.5 Cost. There is no cost associated with this alternative.

4.8.1.6 Reduction of Toxicity, Mobility, or Volume. The no action alternative will not result in active reduction of toxicity, mobility, or volume of contaminants. There will be natural attenuation of the groundwater contaminant levels, but the no action alternative will not provide any mechanism to monitor the attenuation. Based on current information, there is no need to reduce the mobility, toxicity, or volumes of the constituents detected in the soil.

4.8.1.7 Compliance with ARARs. The no action alternative will not meet the groundwater ARARs for this site. Since the soil has been shown to be protective of groundwater, and the constituents in soil samples were not detected at levels exceeding Industrial Direct Contact Values, the soil meets ARARs.

4.8.2 Alternative 9-2: Limited Action (Natural Attenuation, Monitoring, and Restrictions) Under the limited action alternative, the groundwater contamination will not be contained or treated, but rather monitored as it attenuates by natural processes. Based on the RI Report data, Site 9 soil has been shown to be protective of groundwater because none of the COPCs detected in the soil samples were detected in the groundwater samples at levels exceeding Industrial Drinking Water Values. In addition, the soil at Site 9 does not pose a human health risk. Therefore, the Site 9 soil does not require active remediation.

Initially this alternative will include pre-design activities to verify the extent of the groundwater contamination. This will include the installation of new monitoring wells. Institutional controls will be necessary to prevent use of the groundwater until the constituent levels are below ARARs.

Monitoring of groundwater will assess contaminant levels. It is expected that this alternative will require 10 years for contaminants to attenuate to levels below regulatory limits. In addition, five-year reviews will be completed during the 10 years of remediation. An assessment of Alternative 9-2 follows:

4.8.2.1 Short-Term Effectiveness. Institutional controls will be effective in reducing the likelihood of exposure to groundwater contaminants at the site. Groundwater is currently not used, and is not expected to be used, as a drinking water source at the Alpena CRTC. Therefore, groundwater use should not be an issue.

4.8.2.2 Long-Term Effectiveness. Soil RAOs are met because the soil at the site currently poses no human health or environmental concern. Organic constituents in the groundwater will naturally attenuate to levels meeting ARARs. Therefore, this alternative will be effective over the long-term for the organic constituents in the groundwater. Natural attenuation of metals in groundwater can occur as metals are adsorbed by organic particles in the soil. It is likely that the concentrations of metals in the groundwater will naturally attenuate to levels meeting ARARs. The long-term monitoring included in the alternative will provide the Alpena CRTC personnel with a means to effectively monitor the natural attenuation at the site.

4.8.2.3 Overall Protection of Human Health and the Environment. As the groundwater constituents attenuate to levels below Industrial Drinking Water Values, this alternative will provide overall protection of human health and the environment.

4.8.2.4 Implementability. Technical and administrative feasibility of Alternative 9-2 and the availability of the goods and services needed to implement it are as follows:

4.8.2.4.1 Technical Feasibility. All site activities planned under this alternative are technically feasible. The groundwater monitoring and the five-year reviews required for this alternative are easily implemented.

4.8.2.4.2 Administrative Feasibility. Considerable long-term institutional management is associated with the alternative because the contaminants remain on-site. The MIANG has exclusive rights to the Alpena CRTC property. This will allow easy implementation of the institutional controls and sampling programs through administrative controls.

4.8.2.4.3 Availability of Services and Materials. Materials are readily available for the installation of additional monitoring wells. Contractor services are readily available to complete the additional sampling activities, monitoring, and the five-year reviews.

4.8.2.5 Cost. The costs associated with this alternative are presented in Table 4-16. Assuming a 7 percent discount rate, the 10-year, present-worth cost for this alternative is $80,682 (-30 to +50 percent). Assumptions for the cost estimate are presented in Appendix A-6.

4.8.2.6 Reduction of Toxicity, Mobility, or Volume. The limited action alternative will not result in active reduction of toxicity, mobility, or volume of inorganic contaminants. Natural attenuation will result in the reduction of toxicity, mobility, and volume of the organic constituents in groundwater. Based on the current site information, there is no need to reduce the mobility, toxicity, or volume for the constituents detected in the soil.

4.8.2.7 Compliance with ARARs. As the constituents in the groundwater naturally attenuate, this alternative will meet groundwater ARARs. Since the soil has been shown to be protective of groundwater, and because the constituents in soil samples were not detected at levels exceeding the Industrial Direct Contact Values, the soil currently meets ARARs.

TABLE 4-16
Cost Estimate for Alternative 9-2: Limited Action
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS (DDC)				
Institutional Controls (a)	1	lump sum		$10,000
PRE-DESIGN ACTIVITIES				
Work Plans/Sampling Plans (j)	1	lump sum		$4,000
Well Installation (b)	1	lump sum		$1,800
Groundwater Sampling (g)	1	lump sum		$4,000
INDIRECT CAPITAL COSTS				
Contingency (a)	1	lump sum		$5,000
		TOTAL CAPITAL COSTS		$24,800
ANNUAL O&M COSTS				
MONITORING				
Groundwater Monitoring (c)	1	yearly		$7,000
		TOTAL ANNUAL COSTS		$7,000
FIVE-YEAR COSTS				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,500
Report Preparation	1	lump sum		$1,500
		FIVE YEAR REVIEW COSTS		$5,500
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	10	years (m)		
		TOTAL PRESENT WORTH		$80,682

Assumptions for this cost estimate are located in Appendix A-6.

4.8.3 Alternative 9-3: Aboveground Groundwater Treatment (Air Stripping and Ion Exchange)

Alternative 9-3 will include treatment of groundwater, but no treatment for the soils. Based on the RI Report data, Site 9 soil has been shown to be protective of groundwater. In addition, the soil at Site 9 does not pose a human health risk. Therefore, the Site 9 soils do not require remediation.

The groundwater at Site 9 will be treated using an air stripper to remove the organic constituents and an ion exchange unit to remove inorganic constituents. Initial pre-design activities will be completed to verify the extent of the groundwater contamination. Pre-design activities will also include a pumping test and a bench scale test for the ion exchange system. Groundwater will be extracted using groundwater extraction wells and pumped into the air stripper and ion exchange units. The treated groundwater will then be reinjected into the aquifer. Groundwater modeling is required to determine the exact placement of the extraction wells and the reinjection wells. Based on hydrogeologic information presented in the RI Report and professional experience in designing groundwater extraction systems at sites with similar hydrogeological characteristics, the estimated total groundwater extraction rate is between 30 and 75 gpm. Groundwater will be monitored to assess the performance of the groundwater treatment system. Institutional controls will prevent the use of groundwater until appropriate levels are met for the groundwater.

It is expected that this alternative will require 10 years to remediate contamination to levels below the regulatory limits. In addition, five-year reviews will be completed during this time. An assessment of Alternative 9-3 follows:

4.8.3.1 Short-Term Effectiveness. Institutional controls will be effective in reducing the likelihood of human exposure to groundwater contaminants at the site during remediation efforts. Groundwater use is not a major concern because the Alpena CRTC does not currently use the groundwater and is not planning on using the groundwater as a source of drinking water. Based on the information presented in the RI Report, there are no human health concerns associated with the soil.

4.8.3.2 Long-Term Effectiveness. The soils at the site currently pose no human health or environmental concern. This alternative will be effective over the long-term for reducing levels of organic and inorganic constituents in the groundwater. This alternative meets the soil and groundwater RAOs presented in Section 2.3.

4.8.3.3 Overall Protection of Human Health and the Environment. Remediation through air stripping of the organic constituents and ion exchange of the inorganic constituents in groundwater will provide overall protection of human health and the environment.

4.8.3.4 Implementability. The technical and administrative feasibility of Alternative 9-3 and the availability of the goods and services needed to implement it are as follows:

4.8.3.4.1 Technical Feasibility. All site activities planned under this alternative are technically feasible. The groundwater monitoring and the five-year reviews required for this alternative are easily implemented.

4.8.3.4.2 Administrative Feasibility. The MIANG has exclusive rights to the Alpena CRTC property. Therefore, long-term management for the institutional controls can be easily implemented.

4.8.3.4.3 Availability of Services and Materials. Materials are readily available for the installation of the extraction and reinjection wells, the air stripping system, ion exchange unit and associated equipment, and additional monitoring wells. Contractor services are readily available to complete additional sampling activities, the installation and O&M of the air stripping and ion exchange systems, groundwater monitoring, and the five-year reviews.

4.8.3.5 Cost. The costs associated with this alternative are presented in Table 4-17. Assuming a 7 percent discount rate, the 10-year, present-worth cost for this alternative is $723,757 (-30 to +50 percent). Assumptions for the cost estimate are presented in Appendix A-6.

TABLE 4-17
Cost Estimate for Alternative 9-3: Aboveground Groundwater Treatment
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
CAPITAL COSTS				
DIRECT CAPITAL COSTS (DDC)				
Deed Restrictions (a)	1	lump sum		$10,000
PRE-DESIGN ACTIVITIES				
Work Plans/Sampling Plans (j) (k)	1	lump sum		$7,000
Well Installation (b)	1	lump sum		$1,800
Groundwater Sampling (g)	1	lump sum		$4,000
Groundwater Modeling (d)	1	lump sum		$20,000
Bench Scale Test/Pump Test	1	lump sum		$17,000
ABOVEGROUND GROUNDWATER TREATMENT (Equipment and Construction Cost) (e)				
Air Stripping and Ion Exchange Packages	1	lump sum	$132,000	$132,000
Mechanical Installation	1	lump sum	$24,200	$24,200
Electrical Installation	1	lump sum	$17,300	$17,300
Building Installation	1	lump sum	$17,900	$17,900
Extraction and Injection Well Installation	1	lump sum	$22,000	$22,000
Trenching and Underground Piping	200	ft	$36	$7,200
Mobilization/Demobilization (l)	5% of Equipment and Construction Cost			$11,030
	DIRECT CAPITAL COSTS (DDC)			$291,430
INDIRECT CAPITAL COSTS				
Engineering	6% of DDC			$17,486
Construction Oversight/Technical Support	15% of DCC			$17,486
Permitting	8% of DDC			$23,314
Contingency	20% of DDC			$58,286
	INDIRECT CAPITAL COSTS			$116,572
	TOTAL CAPITAL COSTS			$408,002
ANNUAL O&M COSTS				
MONITORING				
Groundwater Monitoring (c)	1	yearly		$7,000
GROUNDWATER TREATMENT				
Treatment Costs (i)	1	yearly		$16,000
Influent/Effluent Monitoring (f)	1	yearly		$5,000
Maintenance Costs (h)	1	yearly		$16,000
	TOTAL ANNUAL COSTS			$44,000

TABLE 4-17
Cost Estimate for Alternative 9-3: Aboveground Groundwater Treatment
Alpena Combat Readiness Training Center
Alpena, Michigan

ITEM/DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
FIVE-YEAR COSTS				
Planning	1	lump sum		$500
Site Assessment & Review of Monitoring Data	1	lump sum		$3,500
Report Preparation	1	lump sum		$1,500
		FIVE YEAR REVIEW COSTS		$5,500
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	10	years (m)		
		TOTAL PRESENT WORTH		$723,757

Assumptions for this cost estimate are located in Appendix A-6.

4.8.3.6 Reduction of Toxicity, Mobility, or Volume. The air stripping system and ion exchange unit will result in the active reduction of toxicity, mobility, and volume of detected constituents in the groundwater. Based on current information, there is no need to reduce the toxicity, mobility, or volume of the constituents detected in the soil.

4.8.3.7 Compliance with ARARs. As the organic and inorganic constituents are extracted and removed from the groundwater, this alternative will meet ARARs for the groundwater. Since the soil has been shown to be protective of groundwater and constituents were not detected in soil samples at levels exceeding Industrial Direct Contact Values, the soil meets ARARs.

Comparative Analysis of Site 9 Alternatives

Alternative 9-2 is considered the alternative of choice for Site 9. The limited action alternative (Alternative 9-2) will be protective of human health and the environment. The alternative will meet RAOs and ARARs established for groundwater and soil. Natural attenuation has been shown to be effective on BTEX compounds and should also be effective in reducing the concentration of lead in the groundwater. While the natural attenuation is occurring, institutional controls will prevent human exposure to groundwater impacts.

The aboveground groundwater treatment alternative (Alternative 9-3) will be protective of human health and the environment. The alternative will meet RAOs and ARARs for groundwater and soil. Aboveground groundwater treatment will not necessarily result in a faster remediation than natural attenuation. Groundwater modeling and aquifer testing will be necessary to determine the time necessary for treatment. The number and detected levels of constituents (especially for lead) do not warrant active remediation. The limited action alternative will effectively protect human health while monitoring the groundwater contamination.

The no action alternative (Alternative 9-1) will not protect human health and the environment. This alternative will not meet ARARs or RAOs and will not be considered an acceptable alternative.

5.0 RECOMMENDED ALTERNATIVES

This section presents the recommended remedial alternatives for the Alpena CRTC sites.

5.1 SITE 1

The recommended remedial alternative for Site 1 involves the monitoring of the soil and groundwater contamination for 10 years as the constituent levels naturally attenuate. The alternative also includes institutional controls to protect human health while the site is being monitored. The institutional controls will include restrictions on the use of groundwater and requirements for construction activities (such as the use of respirators). This alternative will provide the most cost effective remediation of soil and groundwater at Site 1.

Two active treatment alternatives were considered for Site 1 soil and groundwater. The active treatment technologies are expected to take nearly as long as the natural attenuation process. Similar institutional controls would be required during the remediation to protect human health. The active treatment costs are much more expensive than the limited action alternative. The cost of active remediation of Site 1 is not justified for the levels of contamination at the site.

The no action alternative was also evaluated for Site 1. This alternative is unacceptable because it would not provide protection from the unacceptable non-cancer risk identified at the site.

5.2 SITE 3

The recommended alternative for this site is the no action alternative. Based on the information in previous reports, this site does not pose a threat to human health or the environment. There were no detections at the site in excess of ARARs. The site currently meets all RAOs established in this FS.

A limited action alternative was also evaluated for this site. The limited action alternative would involve additional sampling at the site. There is sufficient sampling information to support the no action alternative for Site 3, therefore, additional sampling is not necessary.

5.3 SITE 5

The recommended remedial alternative for Site 5 involves the monitoring of groundwater contamination for 10 years as the constituent levels naturally attenuate. The alternative also includes institutional controls to protect human health while the site is being monitored. The institutional controls will include restrictions on the use of groundwater. Historical information for the site has shown a decrease in the benzene in the groundwater over time. This decrease in the benzene concentrations indicates that attenuation is occurring by natural processes. This alternative will provide the most cost effective remediation of groundwater at Site 5. Based on the information presented in previous reports, the soil at Site 5 does not require remediation.

Two active treatment alternatives (air-sparging and air stripping) were considered for Site 5 groundwater. The active treatment technologies are expected to take nearly as long as the natural attenuation. Similar institutional controls would be required during the remediation to protect human health. The active treatment costs are much more expensive than the limited action alternative. Current information on the site indicates that contamination is attenuating through natural processes. Therefore, the contamination levels at Site 5 do not warrant active remediation.

The no action alternative was also evaluated. This alternative is unacceptable because it does not guarantee that groundwater will not be used until acceptable levels are obtained. This alternative will provide no mechanism to show when the constituents have attenuated to acceptable limits.

5.4 SITES 6 AND 7

The recommended remedial alternative for Sites 6 and 7 involves the monitoring of groundwater contamination for 5 years as the constituent levels naturally attenuate. The alternative also includes institutional controls to protect human health while the site is being monitored. This alternative will provide the most cost effective remediation of groundwater at Sites 6 and 7. The most recent round of groundwater sampling at Sites 6 and 7 showed no constituents in excess of Drinking Water Values. Due to the historical nature of the activities that occurred at these sites, it will be reasonable to complete additional rounds of sampling to confirm the 1993 results.

Based on the information presented in previous reports, the soil at Sites 6 and 7 does not require remediation.

The no action alternative was also evaluated. As indicated above, additional rounds of sampling at these sites will confirm the 1993 sampling round. The no action alternative would not provide any additional confirmatory sampling.

5.5 SITE 8

The recommended alternative for this site is the no action alternative. Based on the information in previous reports, this site does not pose a threat to human health or the environment. There were no detections at the site in excess of ARARs during soil and groundwater sampling. The site currently meets all RAOs established in this FS.

A limited action alternative was also evaluated for this site. The limited action alternative would involve additional sampling at the site. There is sufficient sampling information to support the no action alternative for Site 8, therefore, additional sampling is not necessary.

5.6 SITE 9

The recommended remedial alternative for Site 9 involves the monitoring of groundwater contamination for 10 years as the constituent levels naturally attenuate. The alternative also includes institutional controls to protect human health while the site is being monitored. The institutional controls will include restrictions on the use of groundwater. This alternative will provide the most cost effective remediation of groundwater at Site 9. Based on the information presented in previous reports, the soil at Site 9 does not require remediation.

One active treatment alternative (air stripping/ion exchange) was considered for Site 9 groundwater. The active treatment technology alternative is expected to take nearly as long as the natural attenuation. Similar institutional controls would be required during the remediation to protect human health. The active treatment costs are more expensive than the limited action

alternative. The cost of active remediation at Site 9 is not justified for the levels of contamination at the site.

The no action alternative was also evaluated. This alternative is unacceptable because it does not guarantee that groundwater will not be used until acceptable levels are obtained. This alternative will provide no mechanism to show when the constituents have attenuated to acceptable limits.

6.0 REFERENCES

Miller, J.B., and F.R. Twenter, 1986. "Michigan Surface Water Resources," *National Water Summary - Michigan. U.S. Geological Survey Water Supply Paper 2300,* U.S. Geological Survey, Lansing, Michigan.

Hazardous Materials Technical Center, 1985. *"Installation Restoration Program Records Research: Phelps Colleens Air National Guard Base, Alpena, Michigan.*

U.S. Environmental Protection Agency, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.*

The Earth Technology Corporation, 1995. *Final Remedial Investigation Report, Alpena Combat Readiness Training Center Alpena County Regional Airport, Michigan Air National Guard,* Alpena, Michigan

APPENDIX A-1
COST ESTIMATE ASSUMPTIONS FOR ALPENA CRTC SITE 1

(a) Estimated cost.

(b) Assumes installation of two wells, each 12 ft deep.

(c) Based on existing contaminant depths and locations, assumes sampling of 4 existing monitoring wells on an annual basis. Groundwater samples analyzed for VOCs, SVOCs, and metals.

(d) Site wide groundwater modeling needs to be performed only once for the entire Alpena CRTC. Costs for modeling distributed among sites. Modeling will include results for each specific site requiring remediation.

(e) Uses Fixed Capital Ratio Method from "Plant Design and Economics for Chemical Engineers", Third Edition, McGraw-Hill Book Company, pg. 179, Table 17.

(f) Influent and effluent groundwater sampling will occur monthly, analysis will include BTEX, antimony, and pH.

(g) Additional groundwater samples collected from two monitoring wells and analyzed for VOCs, SVOCs, and metals.

(h) Assumes collection of six soil samples and analysis of VOCs, SVOCs, and metals.

(i) Based on existing contaminant depths and locations, soil monitoring includes collection of two soil samples and analysis of VOCs, SVOCs, metals.

(j) Maintenance costs are based on 5 percent of the capital equipment cost plus labor to maintain the unit at one operator for half of a day per week at $45 per hour.

(k) Treatment cost include the utility service and resin replacement costs.

(l) Cost includes the preparation of Work Plans/Sampling Plans for pre-design groundwater sampling, and annual groundwater monitoring and 5-year soil monitoring activities.

(m) Mobilization/demobilization costs are assumed to be 5.0 percent of the construction costs. This includes all up-front costs for contractor including general set-up costs, temporary facilities, preparation of plans and submittals, and preparation of contractor Health and Safety Plan.

APPENDIX A-1 (continued)
COST ESTIMATE ASSUMPTIONS FOR ALPENA CRTC SITE 1

(n) In addition to the costs listed in assumption (l), this cost includes Work Plan/Sampling Plan for monitoring of influent/effluent streams to treatment system.

(o) Selection of 10 year remediation period for every remedial alternative based on preliminary assessment of site, and provides a similar basis to compare alternative costs.

APPENDIX A-2
COST ESTIMATE ASSUMPTIONS FOR ALPENA CRTC SITE 3

(a) Estimated cost.

(b) Cost includes preparation of Work Plans/Sampling Plans for groundwater monitoring activities.

(c) Assumes sampling of 4 existing monitoring wells. Wells to be sampled 3 times over a 5 year period. Groundwater will be analyzed for VOCs, SVOCs, and metals.

APPENDIX A-3
COST ESTIMATE ASSUMPTIONS FOR ALPENA CRTC SITE 5

(a) Estimated cost.

(b) Assumes installation of four wells, 2 at 10 ft deep and 2 at 15 ft deep.

(c) Based on existing contaminant depths and locations, assumes sampling of 4 existing monitoring wells on an annual basis. Groundwater analyzed for VOCs, SVOCs and metals.

(d) Site wide groundwater modeling needs to be performed only once for the entire Alpena CRTC. Costs for modeling distributed among sites. Modeling will include results for each specific site requiring remediation.

(e) Uses Fixed Capital Ratio Method from "Plant Design and Economics for Chemical Engineers", Third Edition, McGraw-Hill Book Company, p. 179, Table 17.

(f) Influent and effluent groundwater sampling will occur monthly, analysis will include BTEX and pH.

(g) Additional groundwater samples will be collected from four monitoring wells and analyzed for VOCs, SVOCs, and metals.

(h) Maintenance costs are based on 5 percent of the capital equipment cost plus labor to maintain the unit at one operator half a day per week at $45 per hour.

(i) Treatment cost include the utility service costs.

(j) Cost includes the preparation of Work Plans/Sampling Plans for pre-design groundwater sampling, and annual groundwater monitoring activities.

(l) Mobilization/demobilization costs are assumed to be 5.0 percent of the construction costs. This includes all up-front costs for contractor including general set-up costs, temporary facilities, preparation of plans and submittals, preparation of contractor Health and Safety Plan.

(m) In addition to the costs listed in assumption (k), this cost includes Work Plan/Sampling Plan for monitoring of influent/effluent streams to treatment system.

(n) Number of sparge wells based on preliminary assessment of site.

(o) Selection of 10 year remediation period for every remedial alternative based on preliminary assessment of site, and provides a similar basis to compare alternative costs.

APPENDIX A-4
COST ESTIMATE ASSUMPTIONS FOR ALPENA CRTC SITES 6/7

(a) Estimated cost.

(b) Cost includes preparation of Work Plans/Sampling Plans for groundwater monitoring activities.

(c) Assumes sampling of 4 existing monitoring wells. Wells to be sampled 3 times over a 5 year period. Groundwater will be analyzed for VOCs, SVOCs, and metals.

APPENDIX A-5
COST ESTIMATE ASSUMPTIONS FOR ALPENA CRTC SITE 8

(a) Estimated cost.

(b) Cost includes preparation of Work Plans/Sampling Plans for groundwater monitoring activities.

(c) Assumes sampling of 4 existing monitoring wells. Wells to be sampled 3 times over a 5 year period. Groundwater will be analyzed for VOCs, SVOCs, and metals.

APPENDIX A-6
COST ESTIMATE ASSUMPTIONS FOR ALPENA CRTC SITE 9

(a) Estimated cost.

(b) Assumes installation of one well, 30 ft deep.

(c) Based on existing contaminant depths and locations, assumes sampling of 3 existing monitoring wells on an annual basis. Groundwater analyzed for VOCs, SVOCs, and metals.

(d) Site wide groundwater modeling needs to be performed only once for the entire Alpena CRTC. Costs for modeling distributed among sites. Modeling will include results for each specific site requiring remediation.

(e) Uses Fixed Capital Ratio Method from "Plant Design and Economics for Chemical Engineers", Third Edition, McGraw-Hill Book Company, p. 179, Table 17.

(f) Influent and effluent sampling will occur monthly, analysis will include BTEX, lead, and pH.

(g) Additional groundwater samples will be collected from one well and analyzed for VOCs, SVOCs, and metals.

(h) Maintenance costs are based on 5 percent of the capital equipment cost plus labor to maintain the unit at one operator for half of a day per week at $45 per hour.

(i) Treatment costs include the utility service and resin replacement costs.

(j) Costs include the preparation of Work Plans/Sampling Plans for pre-design groundwater sampling and annual groundwater monitoring activities.

(k) In addition to the costs listed in assumption (j), this cost includes Work Plan/Sampling Plan for monitoring of influent/effluent streams to the treatment system.

(l) Mobilization/demobilization costs are assumed to be 5.0 percent of the construction costs. This includes all up-front costs for contractor including general set-up costs, temporary facilities, preparation of plans and submittals, and preparation of contractor Health and Safety Plan.

(o) Selection of 10 year remediation period for every remedial alternative based on preliminary assessment of site, and provides a similar basis to compare alternative costs.

PUBLIC MEETING MINUTES - FEASIBILITY STUDY

MICHIGAN AIR NATIONAL GUARD
COMBAT READINESS TRAINING CENTER
ALPENA, MICHIGAN

Contract No: DAHA90-94-D-0013
Delivery Order No: 12

Prepared For:

Air National Guard
Andrews AFB, Maryland

Prepared By:

Montgomery Watson
Novi, Michigan

Public Meeting Minutes - Feasibility Study
December 14, 1995
Alpena Combat Readiness Training Center
Michigan Air National Guard
Alpena, Michigan

Meeting Attendees:

Doug Barber	Contractor, Montgomery Watson
Mary Bray	Alpena News
Mr. Canfield	Property Owner
Elayne Crowe	Contractor, Montgomery Watson
Capt. Fred Kimble	Environmental Coordinator, Alpena CRTC
Margaret (Peg) Moffett	Public Affairs Officer, Air National Guard
Paul Wheeler	Project Manager, Air National Guard

INTRODUCTION

These minutes document the Public Meeting held to solicit comments on the Feasibility Study (FS) completed for Sites 1, 3, 5, 6/7, 8, and 9 at the Alpena Combat Readiness Training Center (CRTC) in Alpena, Michigan. The meeting was held on December 14, 1995 at the Fletcher Motel, 1001 US-23 North, Alpena, Michigan. Meeting attendees are listed above.

Certified minutes were recorded for the meeting and are provided as Attachment A. A brief summary of the meeting highlights is provided below.

MEETING HIGHLIGHTS AND TOPICS

Introduction

M. Moffett opened the meeting. She introduced the representatives at the meeting and explained the objective of the meeting. In addition, Ms. Moffett provided an overview of the Installation and Restoration Program (IRP) and how the Alpena CRTC FS related to the program.

Site Information

Capt. Kimble provided an overview of the Alpena CRTC and a description of the Alpena CRTC sites that are included in the FS.

Feasibility Study

M. Moffett and D. Barber explained the process involved in the development of a feasibility study. M. Moffett explained that the draft final FS was complete for Alpena. In addition, she indicated that copies of the FS for the Alpena CRTC were available in the library for public review and comment.

Past Efforts
Capt. Kimble provided a general history of the investigative work that has been completed in support of the Alpena CRTC FS. He explained how the sites were identified at the base and the actions/investigations completed to determine which sites were included in the FS. The preliminary assessment, the site investigation, and the remedial investigation steps were included in his discussion.

Remediation Goal
Capt. Kimble explained that the goal of the program was to close all 17 sites that had initially been identified for the Alpena CRTC. The base is currently addressing pollution prevention actions to prevent any future contamination at the base.

Finalizing the FS and Initiating Remedial Actions
Capt. Kimble and M. Moffett explained that the FS is a draft final document. In addition to the public review, the document is currently being reviewed by state regulatory agencies. Once all comments are received, the document will be finalized. After finalizing the FS, decision documents will be prepared to document the selected alternative. The base will then begin to implement the selected alternatives.

Selected Alternatives
It was explained that field investigations showed very low levels of contamination at the Alpena CRTC sites. The proposed alternatives for the CRTC sites in the FS involved continued monitoring of soil and/or groundwater for five sites. The minimal contamination at these sites is expected to naturally attenuate over time. The sites will be monitored to verify that natural attenuation is occurring. There are two sites that do not require additional remedial efforts.

Previous Remedial Actions
Capt. Kimble explained that the base had already taken action on sites that posed a greater risk to human health and/or the environment. Sites 2 and 4 at the Alpena CRTC have already been remediated, including soil remediation and lead stabilization. The state is currently reviewing the actions taken on at the sites to verify that remediation of the sites is complete.

Contaminated Groundwater
Mr. Canfield was concerned because he had heard that groundwater (used for drinking water) at the site was contaminated. Capt. Kimble explained that he was unaware of contamination in the drinking water. Capt. Kimble explained that the base takes samples quarterly and has them tested. Results are sent to the Department of Public Health. He indicated that one well does exhibit high chloride levels, but that this is not a health concern.

Former Landfill

Sites 6 and 7 cover an area which was formerly a landfill. Capt. Kimble explained that the proposed alternative at these sites involves continued groundwater monitoring. Capt. Kimble explained that during field investigation, no drums were found in the landfill. The debris consists mainly of construction materials. Mr. Wheeler explained that soil and groundwater sampling at these sites showed little contamination.

Sewage Treatment Plant

Mr. Canfield asked if the sludge from the treatment plant is dumped into the river. Capt. Kimble explained that the sewage plant is not part of the FS, but that it was part of Capt. Kimble's responsibilities. The treatment plant is regulated under the Clean Water Act. Capt. Kimble indicated that the sludge from the treatment plant is not dumped into the river.

Closing

M. Moffett closed the meeting. She indicated that Capt. Kimble was available for any additional questions concerning the FS. She explained that the public review period would continue until the end of December. Any questions or concerns could be submitted by the public during that time.

RESPONSIVENESS SUMMARY - FEASIBILITY STUDY - PUBLIC MEETING

MICHIGAN AIR NATIONAL GUARD
COMBAT READINESS TRAINING CENTER
ALPENA, MICHIGAN

Contract No: DAHA90-94-D-0013
Delivery Order No: 12

Prepared For:

Air National Guard
Andrews AFB, Maryland

Prepared By:

Montgomery Watson
Novi, Michigan

Responsiveness Summary
Feasibility Study - Public Meeting
Combat Readiness Training Center
Alpena, Michigan

This document is intended to addresses public comments concerning the Feasibility Study (FS) completed for Sites 1, 3, 5, 6/7, 8, and 9 at the Alpena Combat Readiness Training Center (CRTC) in Alpena, Michigan. A public review/comment period was held from November 30, 1995 through December 30, 1995. During this period, copies of the FS were made available to the public through a local library. Additionally, notices were placed in local newspapers to solicit comments. A Public Meeting was held on December 14, 1995.

During the Public Meeting, members of the Air National Guard (ANG) and Montgomery Watson discussed the FS with meeting attendees. The meeting included a general introduction of the Installation and Restoration Program (IRP) and how the Alpena CRTC FS relates to the program. ANG personnel provided an overview of the Alpena CRTC and a description of the sites included in the FS. In addition, ANG personnel explained the goal of the remediation program for the Alpena CRTC. The ANG and Montgomery Watson then addressed the comments and concerns of the meeting attendees.

No written public comments were generated as a result public review/comment period. This responsiveness summary will address the comments generated during the Public Meeting.

Contamination Level

During the Public Meeting it was explained that the field investigation at Sites 1, 3, 5, 6/7, 8, and 9 has shown very low levels of contamination in groundwater and soil. A Baseline Risk Assessment (BRA) was completed at the sites to determine the potential risk posed to human health by the constituents detected at the sites. The results of the BRA indicate that none of the sites pose an unacceptable cancer risk, and Site 1 is the only site that poses an unacceptable non-cancer risk. The unacceptable non-cancer risk is for future excavation workers at the site. It was explained that the proposed alternative for Site 1 will include institutional controls to prevent future excavation work without protective clothing for workers.

Captain Kimball (Environmental Coordinator at the Alpena CRTC) explained that remedial actions have already been taken at sites on the base that were determined to pose a more significant risk to human health or the environment. Remedial actions have already been completed at Sites 2 and 4, including soil remediation and lead stabilization.

At the Public Meeting, Mr. Canfield (property owner) indicated that he was concerned because he had heard that groundwater (used for drinking water) was contaminated at the base. Captain Kimball indicated that the base takes samples quarterly and has them tested. The results are sent to the Michigan Department of Health. He indicated that he was unaware of any contamination of drinking water at the base. One well at the base does exhibit high chloride levels, but high chloride levels are not a health concern.

Selected Alternatives
The Public Meeting included a discussion of the selected alternatives for the Alpena CRTC sites. The discussion included the selected alternatives, other alternatives that were considered, the time required for the alternatives, and the cost of the alternatives.

Based on the investigative results, two sites (Sites 3 and 8) do not require additional remedial actions.

A limited action alternative was proposed for the remaining sites. The limited action will include monitoring of groundwater and/or soil at the sites as the constituent levels naturally attenuate. It was determined that constituents levels at the sites do not warrant active remediation, and that natural attenuation would be an effective alternative for the sites. Each site will be monitored for a minimum of 5 years. At that time, a determination will be made to continue monitoring or to close the site.

Former Landfill
Sites 6 and 7 cover an area which was formerly a landfill for the base. Captain Kimball explained that the proposed alternative at these sites involves continued groundwater monitoring. Mr. Canfield expressed a concern that drums may have been buried in the landfill. Captain Kimball explained that investigation was completed at the site to specifically determine if drums had been buried at the landfill. The investigation found no drums, only a couple metal street-signs and a few tins cans. The debris in the landfill consists mainly of construction materials. Groundwater sampling at the site showed little contamination in the groundwater at these sites.